SCIENTIFIC AMERICAN SUPPLEMENT. No. 914

Copyright by Munn & Co., 1893.

Scientific American Supplement, Vol. XXXVI. No. 914. | NEW YORK, JULY 8, 1893. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

THE INTERNATIONAL EXPOSITION AT CHICAGO—A STREET IN CAIRO.

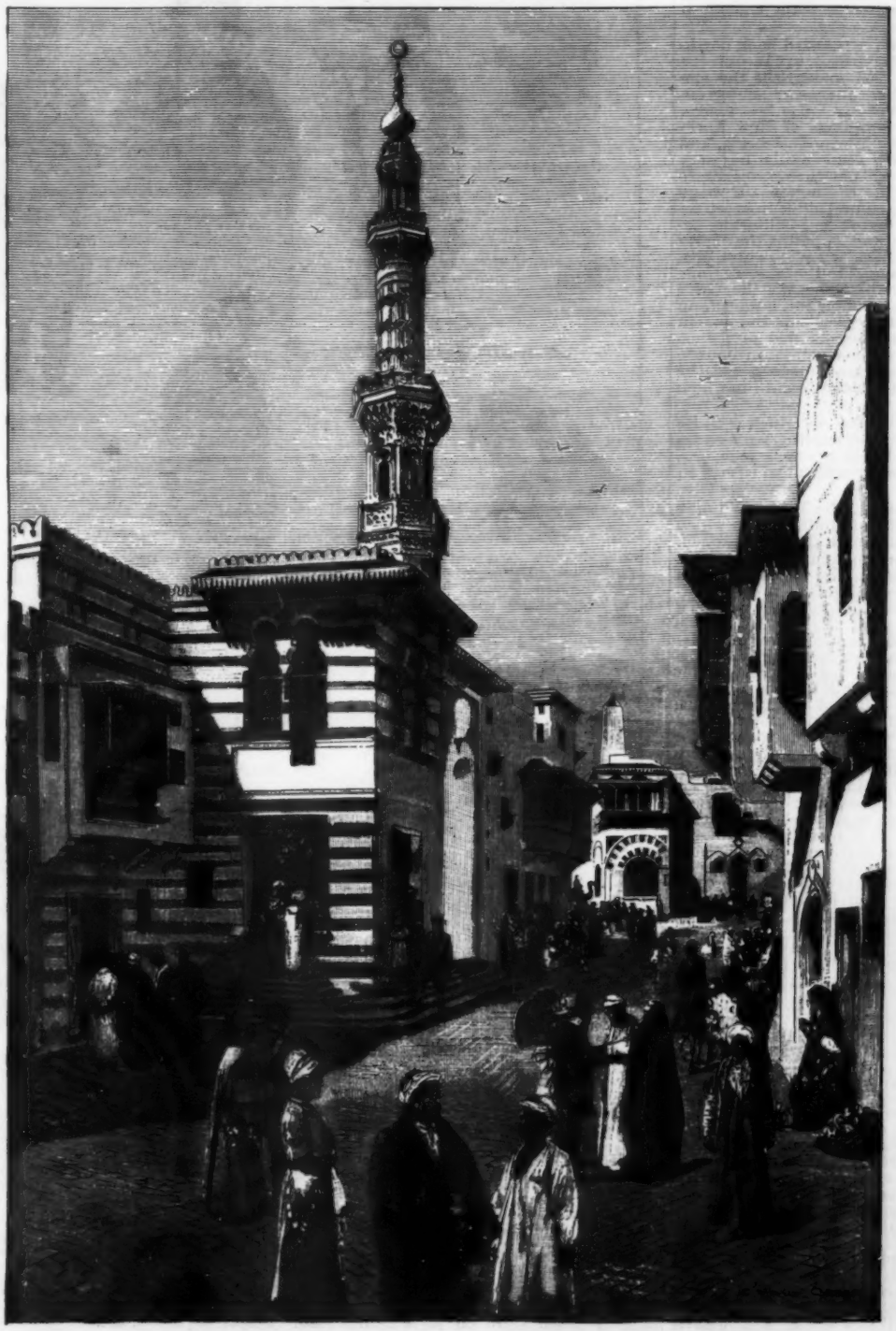
A GREAT improvement on former exhibitions are separate exhibitions of several nations and races to permit of following their own life, their work and daily occupations, as well as their special trades, the same as in their native country. The former exhibitions have been principally long rows of show cases containing the principal industrial and art products of their respective countries. This kind of exhibition is antiquated, and would hardly be viewed with any interest. During the Paris Exposition in 1889, the idea of introducing, besides the products of the several countries, the natives of the same, was conceived. The Egyptians were the first to carry out this idea by the erection of a street in Cairo on the Champs de Mars, at that Exposition, and the success of this undertaking was such that quite a number of tribes appear this year in Jackson Park, in Chicago.

While the Park itself is devoted to the principal buildings, the long stretch called "Midway Plaisance" contains a large number of ethnographical exhibitions which form a great attraction for all those who combine study with pleasure. There is not a single place on the globe which shows in such a small space such a tremendous combination of races, human types, costumes and customs. The natives sent from Lapland, Patagonia, from Java, Borneo, Alaska and from the Congo are not packed together in tenement houses, but are housed in buildings corresponding to those in their native countries, with the blue sky of Chicago over the villages of Malay, India and Lapland; over German and Irish settlements, Indian wigwams, African bamboo huts, Ceylon bungaloes and temple buildings of Annam or Japan. Among all these remarkable villages, old Cairo, no doubt, takes the first prize.

At a considerable expense, one of the principal city parts of the old residential Cairo has been erected in the marshy beach of Lake Michigan, and has been reproduced with such accuracy that a traveler to the old city will most certainly think himself in Egypt, as the same buildings, with the white and red horizontal stripes, are found, and also the window screens behind which lovely black eyes peep upon the passers-by in the street. The same mosques with their beautiful architecture and their large portals, together with the beautiful minarets are found, as well as the small cafes and bazars, and niches in which the oriental writers are seated on small round carpets.

The life in the street itself is the same as that in Cairo. Several hundred Egyptians in their picturesque costumes pass through the street with their shuffling gate, as well as the Turk with his red turban and the Assyrian in a blue jacket and large pantaloons. In a corner we find Arabs in large white burnos, their heads covered with tremendous turbans. Between these we find negroes having a jet black skin, who excel the entire colored race of the South. Mounted on donkeys we see a number of rich Arabians, who pass by, preceded by the interesting Sais, with their naked legs, and once in a while there appear in the doors of a cafe pretty little girls in picturesque dresses and white transparent haiko, to induce passers-by to enter and admire their dancing.

What can these people think of this tremendous occidental city within which they are at present located; the city with its many strange houses and its people running after the almighty dollar? Can a greater contrast be found between the dreamy, showy and fairy-tale-like Orient and the telegraphic and telephonic America? — *Ernst v. Hesse-Wartegg in Illustrirte Zeitung.*



THE WORLD'S COLUMBIAN EXPOSITION—A STREET IN CAIRO.
ORIGINAL DRAWING BY C. LIMMER.

THE COLUMBIAN EXPOSITION.

By JOHN MCGOVERN.

Now that the World's Columbian Exposition is fairly opened, it is to be seen that it is more closely allied with the interests of transportation than with any other one line of human effort. In the first place, it is a triumph of American and foreign railroading that an array of exhibits, valued as high as $300,000,000, could be carried a thousand miles inland as well as safely to any seaport. The Krupp cannon is at Chicago, without accident to any of its machinery, but so also is the delicate glassware of Bohemia, in the beautiful Austrian exhibit. The Fisheries building holds one of the most beautiful and difficult animated spectacles of modern times, where fish of both salt and fresh water disport before enraptured thousands. The great bells of the Empress Augusta, which are to return to Berlin, fill the park with their deep and melodious clamor; Liberty Bell stands in Pennsylvania's portal; timbers that defy description rest under the sides of the Washington building; the largest steel shaft so far cast has been hoisted to the top of the 130 ft. towers of the Ferris wheel; the steel structure of the Manufactures building exceeds anything done at the tide-water or since the pyramids; and all these things, which are mentioned merely as indexes and hints, are the results of the science of transportation. Distance no longer defeats the plans of engineers.

The Fair has blessed local Chicago with two new railway enterprises that at once set a portion of her citizens on a parity with the most highly privileged of New York people. The Illinois Central Company, by the erection of triple platforms that reach to the floor of an ordinary car, and through the construction of the special World's Fair cars, which were recently illustrated in the *National Car and Locomotive Builder* [see issue of September, 1892], is able to load trains as fast as a crowd can come, and fourteen minutes later, without stoppage midway, those crowds are at Jackson Park. No less than 300,000 people can thus be taken to the Fair in a forenoon, with no greater delay than they themselves necessitate in buying their tickets. The main causes which make this wonderful feat possible are the high platforms, the side entrances to the cars, so that a thousand people can be seated in half a minute or less, and the admirable approaches to the open-air stations, whereby there is almost no danger to life and limb.

The other triumph of Western transportation is the elevated passenger railway, the "South Side Rapid Transit Railway," running from the heart of Chicago's business district into the Fair grounds. New York has so long used elevated roads that it should be explained that they were only realized in Chicago after a decade of litigation in the courts. There were so many pioneers, who thought a horse car a good thing, that the owners of the surface roads had an easy time keeping out a better service.

Thus all the visitors to Chicago who dwell at inns, and all the people of the South Side—some 700,000 or more—are as well off for transportation, or better, than the folks who go to Coney Island, or travel up and down Manhattan. To accomplish this much has cost the two companies involved several millions of dollars, for the work at the Fair grounds by which the Illinois Central raised all its tracks so that there should be no grade crossings was gigantic. While the Illinois Central is itself an elevated road at Jackson Park, the South Side Elevated road crosses the

Illinois Central before entering the Exposition grounds at a still higher elevation.

I will attempt, first, to offer a general view of the Fair, and if that view is probably already somewhat familiar to the reader, it will greatly aid my efforts to be understood. The swift train runs along the blue lake for eight miles, and as the suburbs are reached the city lots get wider and usually afford room for a few small trees around the houses. For a mile north of Jackson Park this prevalence of green gives a cheering aspect to things, and undoubtedly heightens that feeling of pleasure which the early views of the Exposition usually offer to the visitor. The traveler debarks at about the center of the west side grounds, where a high unpainted board fence frowns upon the interminable line of showmen and fakirs plying their noisy vocation. As the train stops, Midway Plaisance is crossed, which is a narrow stockade that runs as an arm of the Fair off westward one mile.

Centrally, in this mile, stands the colossal Ferris Wheel, named after its inventor. This is the Eiffel Tower of the American Fair. Its axle is to be 130 feet high in the air. Its passengers are to be slowly carried by its periphery a distance of 780 feet in the air, reaching an altitude of 260 feet at the summit. It is still unfinished, and the methods of its construction are similar to those by which the Hall of Arches in the Manufactures building was erected. Midway Plaisance is a prime attraction, and is the real "World's Fair" end of the Exhibition. Its avenue is wide and many of the buildings are characteristic, ingenious, beautiful and expensive.

Let us suppose we are now transported back northward half a mile, and enter the broad avenue of the Fair at Fifty-seventh Street. On our right is the majestic Art Palace, with its two annexes reaching entirely across the park. Before it, in the best places, are the luxurious and noble buildings of New York, Massachusetts, Pennsylvania, Missouri, Georgia, and Minnesota. Crowded upon a semicircular highway that skirts the north end of the park are other State houses, there being a score in this region. If we go south at once, we shall pass, on our right, the very remarkable buildings of Washington and California, between which stands Colorado, and, opposite, the highly Gothicized and peaked buildings of Indiana and Wisconsin. If, however, we go across to the lake, we come on the pretty Iowa structure, which once was the park's pavilion, and as we go south we enter the large group of foreign houses, where Germany leads all the rest in beauty and luxury. Here in a large double semicircle swinging around a pond are sixteen exposition houses, all the headquarters of other governments, and the expressions of that warm and generous regard in which the great republic is held.

We have not entered the Art Palace, which with its triple house offers a collection of paintings not to be seen elsewhere on earth—a day, a month, a year or a life study, according to the information one wishes to acquire.

This is one of the five regions of the Fair. We may now enter the great ellipse of main buildings, in which Illinois, with its towering dome, is always reckoned. This ellipse is nearly a mile long and a quarter of a mile across at the widest point. In its center is an island on which 20,000 different kinds of roses are expected to bloom in the month of June. Viewed from either end, this ellipse is one of the most admirable vistas on earth, and probably the best ever made by the hand of man. Gondolas, each oared by two Venetians in the striped costumes of the Lagune at Saint Mark, ply in the waters; white gulls in great numbers skim the surface looking for fish, and capturing them: electric launches go as silently by; and crowds stand on the bridges unable to leave a scene so novel for others as alluring. Of all the buildings, the Art Palace shows the best front. It is, briefly, an Ionic temple of great size, but with a dome and a water approach. The exquisite fisheries, a triple pavilion, holding the wonders I have mentioned, winds itself around the pond in which it is built. The Government building resembles that of Illinois, having a protuberant dome, capped by a protuberant lantern. It is filled with interesting small exhibits, and is the best built of the large buildings, for it should be understood that the departmental structures are not smooth finished within. Nothing could exceed, however, the care with which many of the buildings of States and foreign nations have been everywhere decorated. A day could be spent in the Government building. Across is the Woman's building, the first built on these grounds, and now furthest behind in installation. The view of Horticultural Hall from here is also very fine. That building somewhat resembles the Capitol at Washington.

We now approach the Manufactures building, the leviathan of the Fair, a structure that grows larger the longer it is studied, one upon the roof of which you may make a promenade of a mile—a house as large as a race-track, as large as a farm—whose inner hall seated 150,000 people last October, the most numerous indoor convocation of history. The best description of it, I think, is to say it is a mountain in Chicago. It looks to us as the Cumberland or Cheat Mountains look to a Denver or Virginia City man. I have seen the Manufactures building from its first post, its first flooring, its first arch, its dedication, until now it blossoms like a fallow field, with pavilions of all sizes, and is filled with chaos and roaring echoes. The best of its exhibits is its roof, and it was more of a dramatic spectacle in building than it now offers. I have never stayed in it, but always taken a different route in passing through. The portals of the foreign nations are ornate—those of Belgium and Austria, so far, leading in beauty. The electroliers hold 75 and 100 arc lights each in circles.

Across from the Manufactures building, on the other side of the ellipse, is the Transportation building, in which there is an exhibit that will occupy most of the time of railroad men when they are in Chicago, and while their families are among the flowers and pictures. This building is conspicuous for its lady-bug decoration, that charming insect having served as a model of color and style. The portal is one of Architect Adler's nests of increasing arches, as seen in the Chicago Auditorium and the Schiller Theater. It is gilded with gold and silver, and is always receiving a new coat of one or the other. Its statues have been white, brown, green, and are now brown again. The kaleidoscopic color-scheme of the Transportation building is one of the Fair mysteries we have not solved.

Side by side stand the Mines and Electricity, each offering many things that ought not to be missed. In the Mines are Stumins remarkable iron display. Ada Rehan in silver, a beautiful copper nugget and several panoramas of paintings. In the Electricity building is the light tower, the mimic theater, Bell's temple and Edison's dynamos. The pavilions here have no windows. We are now come to the grand basin—the heart of the Fair—where the opening day crowds stood. This scene is well pictured through the country, and is a striking return to Greek art. Rows of incandescent bulbs surround the scene at the water's edge and at the cornices. MacMonnies' fountain is at the brink of a convex cascade, and its barge of state is drawn by sea horses with riders. The night illumination here is the *piece de resistance* of 1893.

We now confront three of the most beautiful buildings I have ever seen. I would note the dome of the

THE WORLD'S COLUMBIAN EXPOSITION—INDIVIDUAL TYPES.

Administration, the variety of Machinery Hall and the wealth of sculpture on Agricultural Hall. Beasts of ark-like number gaze peacefully on us from a space a thousand feet wide. Huge bulls and horses guard the landing places, and lions lie at the base of an obelisk. Winged columns support Neptunes with tridents and a golden statue of Liberty stands 60 feet high out of the water. A colonnade screens the lake and another the fifth and southern section of the Fair.

The Administration building is a meeting place. In its plaza bands play. The air of festival here is entirely new to Western American. Machinery Hall comes slowly to a better condition. It has 80 boilers in a row, but its engines are all small in general appearance.

Agricultural Hall is a wilderness of cereal pavilions. Each is exquisite, but the general effect is small. You are in a magnificent grocery. Yet it far exceeds the anticipations of city people, and will probably be a little too gay for the farmers, who will start for the stables.

La Rabida is on the lake shore at the east door of the Agricultural. This is, in brief, a museum of Columbiana, housed in a building which is a reproduction of the monastery where Columbus matured his plan of discovering America. A day may be spent here by scholars.

The south grounds are occupied by Krupp with his cannon, the ethnologists, the leather men, the Indians, the windmills, the power houses, the stock houses, and a hundred other things. It is a low, sandy, unfinished place, which you never reach until you are too weary to leave it.

This, hastily, is the Fair. The Horticultural building holds an inspiring exhibit, probably the favorite one—with its flowers and oranges. I shall return to the Transportation building in a subsequent letter.

I have not here noted the gunboat, the wharf with its railway, the elevated inner railway, which one must not fail to see; the panorama of car sheds, the two terminal stations, the cafes, kiosks, booths, the lawns, the music halls (each an opera house), the Casino, the many service and fire buildings; nor have I attempted to describe Midway Plaisance—itself a World's Fair. But it is well to repeat, in closing, that there are five circles of sight, where you are surrounded by distant buildings that cannot all be seen from any outside place, namely: (1) Midway Plaisance; (2) the State region in front of the Art Palace; (3) the grand ellipse; (4) the grand basin; (5) the stock region south of the south screen.

It is the sublimest spectacle which history has offered. It dwarfs the individual, until, poet or peasant, he sinks into honest admiration. And it is especially flattering to railroad men that the fair is a triumph of their own calling. They have annihilated distance, and the race has left its ships ashore and gone inland, as in the days of Shinar, Thebes and Memphis.—*National Car Builder.*

THE WORLD'S FAIR AT CHICAGO.

WITH SKETCHES BY FREDERIC VILLIERS, SPECIAL ARTIST FOR "BLACK AND WHITE."

OUR special artist writes that "visitors need have no fear of the water when on the Exhibition grounds, for every hundred yards or so are to be found tanks of sterilized water, or at least water from the famous springs of Waukesha. Many of the visitors carry with them empty bottles which they fill to take home, for the water found in the smaller hotels and lodging-houses in the city is full of diphtheria and fever germs. In spite of this danger, however, there is very little serious sickness visible. I say visible, for whenever

AT THE GREAT FAIR—TRANSPORTATION, ANCIENT AND MODERN.

any contagious illness breaks out the fact is rendered only too palpable, as placards notifying the disease are posted on the outer door. Returning to my flat one afternoon I found the following startling announcement affixed to the front door on blood-red paper: 'Scarlet fever here;' and below the notice a warning against the removal of the card."

The Turk is very much in evidence at the World's Fair, and Chicago ladies can, if they choose, ride in the Sedan chairs of Constantinople in the fashion of their ancestors a hundred and fifty years ago. This mode of traveling causes more astonishment to the visitors than the latest Pullman palace car, electric launch, or moving sidewalk. Weary pedestrians can choose between the jaunt of the Sedan chair and the easy-going rubber-tired basket chair shown in the sketch. The policeman of the London force who guards Victoria House, the headquarters of the British Royal Commission at Jackson Park, excites great interest among the Americans, who stand and look at him as though he were one of the most curious exhibits of the Fair. The British exhibits occupy about 315,727 square feet, or about a ninth part of the total area of the building. This is satisfactory, as it must be remembered that, in spite of hostile tariffs, we still find America our best foreign customer, and it behooves our manufacturers to make a goodly display of their wares in such a market.—*Black and White.*

THE TWENTY-HOUR TRAINS BETWEEN NEW YORK AND CHICAGO.

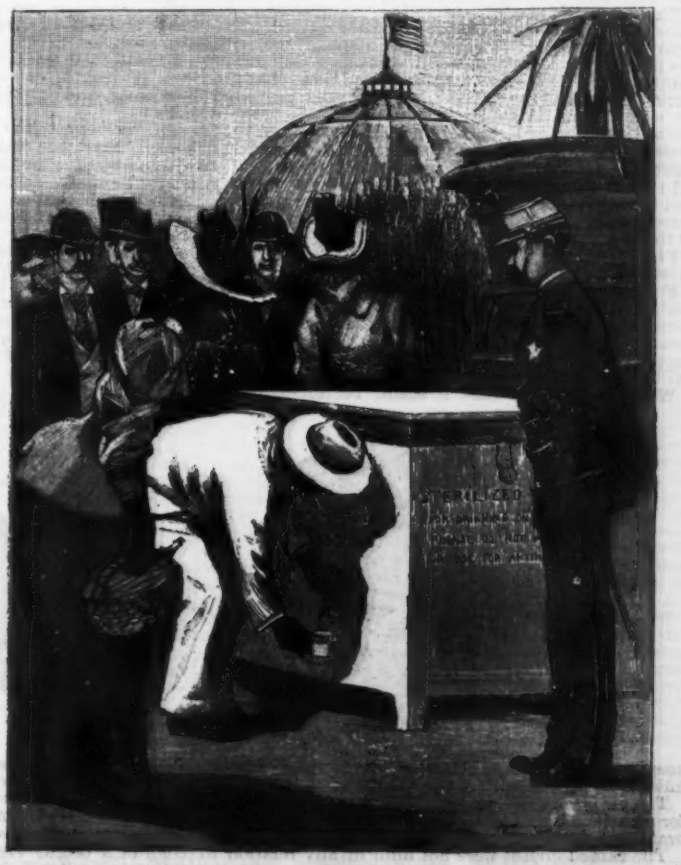
THE "Exposition Flyer" trains over the New York Central & Hudson River and the Lake Shore & Michigan Southern began regular trips on May 28. These trains leave daily at 3 o'clock from New York and at 2 o'clock from Chicago. The train westbound is scheduled to make the run in 20 hours, and the train eastbound in 20 hours and 15 minutes. The writer of these lines took the first train out of New York last Sunday at 3 o'clock eastern time, arrived in Chicago at 10 o'clock central time Monday morning (or, to be precise, at 9:57 o'clock), left Chicago at 2 o'clock central time Monday afternoon, and reached New York again at 11:15 Tuesday morning (or, to be precise again, at 11:19). This first run was a brilliant success in every particular. It was made both ways without the slightest friction or mishap, and everything went as smoothly and as accurately as if those trains had always been running. East and west, on the round trip, the train reached every station ahead of time, except the Grand Central station in New York, and there it got down to Mott Haven on time, if not ahead of time, and the delay of four minutes in getting in was due to well known causes which no human being could control now, but which the company proposes to control within a year.

The running of this train is an unprecedented and brilliant performance. The distance from New York to Chicago, as nearly as we can ascertain, is 964 miles as the "Flyer" runs. This is deducting two miles at Buffalo because the trains do not run into the station, but stop at Seneca Street, to change engines only. They do not take on or let off passengers there. This run of 964 miles is made in 20 hours, being an average of 48·2 miles an hour in motion. The speed on the New York Central is 50·6 miles an hour, and on the Lake Shore & Michigan Southern 46·5. The train makes nine scheduled stops, namely, Albany, Utica, Syracuse, Rochester, Buffalo, Erie, Cleveland, Toledo, and Elkhart. As we have explained above, the stop at Buffalo is to change engines, and not to take on or let off passengers.

The changes of engines and lengths of engine divisions are as below: Albany, 143 miles; Syracuse, 148 miles; Buffalo, 148 miles; Erie, 86 miles; Cleveland, 96 miles; Toledo, 109 miles; Elkhart, 133 miles; and Chicago, 101 miles. The dining car runs are: Going west, Albany to Syracuse, 148 miles, and Toledo to Chicago, 234 miles; going east, Elkhart to Toledo, 133 miles, Syracuse to New York, 291 miles. The composition and weight of the trains is as follows; but the weights are approximate only, inasmuch as we have been unable to get them accurately yet: One combination baggage, buffet and library car made by Barney & Smith, Dayton, O. (this car contains also a barber shop and bath room); two Wagner cars containing toilet rooms, state rooms and 10 sections each; one Wagner car with 16 sections. The difference in these cars is in the absence of certain state rooms in the 16 section car. The approximate weights of these cars are 85,000 lb. for the combination car and 105,000 lb. each for the Wagner cars. The engines hauling the train on the New York Central are of the well known "800 class" used in the Empire State service. These engines have, as is doubtless well known, 19 × 24 in. cylinders, 58 in. boilers and 78 in. drivers. They carry 180 lb. steam pressure and have a total heating surface of 1,818·4 sq. ft. These engines with tender weigh, in working order, about 202,000 lb. On the New York Central end of the line, therefore, the train weighed, say, 602,000 lb. without the dining car, and 700,000 lb. with it. Over the Lake Shore part of the run the trains were hauled by engines of the class shown and described in this issue recently, constructed for this service. They have cylinders 17 × 24 in., 59 in. boilers and 72 in. drivers, and weigh in working order, with tender, 174,000 lb.

The cars are fitted with the Gould vestibule and the Leonard platform and hydraulic buffer. This buffer is entirely new, having been first put in use on these cars, and is the invention of Mr. Arthur G. Leonard, Private Secretary to Mr. H. Walter Webb, Third Vice President of the New York Central. The vestibules cover nearly the entire width of the body of the car, lacking but about eight inches of being flush with the sides. The vestibule floor extends out to this width, and consequently the steps hang out beyond the car sides; they are arranged, therefore, to fold up against the vestibule door. This arrangement of the vestibules is remarkably attractive. They are very comfortable places of observation, having large plate glass windows and floor space enough for camp stools. The buffer is an arrangement of hydraulic plungers equalizing across from one to the other, so that the pressure on the buffers is constant whether the cars are on a straight line or on a curve. These plungers are worked at a pressure of about 500 lb. to the square inch, and in going up and down grades it is found that there is but little change in the pressure recorded. It slacks off 10 or 15 lb. in going up grade, and in going down runs up to perhaps 510 or 515 lb. The practical outcome of

LONDON POLICEMAN AT CHICAGO.



AT THE GREAT FAIR—STERILIZED WATER TANKS.

these buffers and vestibules is an extraordinarily stiff and easy-riding train. At the highest speeds of the "Exposition Flyer" there was very little motion indeed; there was little oscillation either up and down or sidewise, and one could write with considerable comfort on any part of the run. Doubtless a considerable part of the steadiness of the trains was due to the excellent track on the whole line. It should be added that the cars are all new, built for this service, even the dining cars, and are uncommonly simple and elegant in finish. They are all lighted with Pintsch gas and have hot water circulation heated by steam or by Baker heaters.

The speed, as will be seen, does not exceed that of the Empire State express, and no effort was made in the run out or back to break records for short distances. On the favorite racing ground, where No. 999 made its record of a mile in 35 seconds, two observers recorded consecutive miles for a stretch of 25 miles. This distance was made in 21 minutes and 26 seconds, or at the rate of 70 miles an hour, and one mile was made in 48 seconds. The fare on this train between New York and Chicago, with berth, is $36.—*Railroad Gazette.*

PREHISTORIC POTTERY ON EXHIBITION AT THE WORLD'S COLUMBIAN EXPOSITION.

By HENRY HALES.

A FEW years ago I received from a friend information concerning the exhumation, in the Tule Rosa canon, New Mexico, of specimens of ancient pottery, some of which were sent to me from time to time.

These I found were entirely different from any that had hitherto been exhibited in any of the museums in New York or elsewhere.

From conversations held with Prof. Frederick Starr and several other collectors, I found that specimens of this kind of pottery were by no means common; only one collector that I could hear of having a few pieces. The information which I could obtain was so meager that I determined to investigate the matter and to make a personal examination of the locality with a view to getting all obtainable information concerning this singular ware.

I left Ridgewood, N. J., and traveled day and night until I reached the railroad point nearest to my destination, and from there I made the rest of the journey, a distance of 115 miles, with horses. Passing over the "Divide" of the Rocky Mountains, I found that the ruins commenced in the Tule Rosa canon, extending westward to Frisco Creek and the head of the Gila River.

According to the information which I gathered from many sources, these ruins extend down the valley of the Gila and its branch canons as far as the Colorado.

The Rev. H. C. Hovey procured a pot of this same ware near the Colorado in March, 1892.

As far as I could ascertain, there is a great similarity in the location of these ruins.

As a rule, in the valleys of the canons there winds either a creek or a dry watercourse, which had at some period been supplied with running water. Some have, on the lowest level, an alluvial deposit of rich mould; gradually rising from this level, the earth contains clay and broken stone.

This gradual rise continues to the foot of the mountains, and the land may, at some early period, have been cultivated. It is covered in many places with the pinion pine, juniper, a dwarf walnut and other stunted trees. It is in such situations as these that the buried ruins are found, their location only indicated by a few loose stones upon the surface. Sometimes the soil over the tops of the wall is so shallow that nothing grows upon them; a bare spot indicating their position.

In many ruins large trees have grown to maturity and died; the dead trunks, sometimes larger than the surrounding trees, bear a silent witness to the antiquity of the ruins.

I have not visited the ruins of large cities reported to exist in Arizona.

For miles, in some of these canons, the ruins are traceable in smaller or larger groups, proving that at some time the country was thickly inhabited. At the present time I see no possibility that the soil could support such a dense population as then evidently occupied the country.

Water is so scarce that it would be impossible to

FIG. 1.

keep stock about these buildings, as the supply is often miles from the location of the ruins.

The air is very dry, and at times there is no rainfall for months. The rapidity with which moisture evaporates is astonishing.

The ruined houses were not built in any relation to the points of the compass, but in accordance with the natural conformation of the ground.

The site of one continuous ruin embraced a space of seventy-five by one hundred and seventeen feet. The rooms varied in size from twelve by sixteen to twelve by twenty feet, with two smaller rooms six feet square between them.

All the houses were built of flat stone, about fourteen inches square and from two to three inches in thickness. Some partition walls were built of rough stone. All were laid very regularly in a clayish cement and smoothly plastered inside with a hard, light gray plaster.

The distance from the top of the walls to the bottom of the foundations varies from five to eight feet.

One room which I excavated had openings for a door and a window, which I found filled up by a wall of loose stone roughly laid. It would appear from this that the soil had gradually accumulated during the

FIG. 2.

occupation of the building. This assumption is strengthened by the presence, in profuse quantities, of pieces of broken pottery disseminated through the earth which has buried the ruins from the bottom of the foundations to a level with the surrounding country.

Yet, as none of these buildings have been entirely laid bare, much remains to be learned. All the interiors are filled to a level with the surface of the ground; not with drifted sand or alluvial deposit, but with a hard mixture of clay, sand, and small stone, containing but a small quantity of soft earth.

The greater part of this deposit is so hard that it can only be removed by the use of a pick, greatly enhancing the difficulty of removing without damage the skeletons and pottery which it contains.

Whole pots are never found above the foundations.

Under the foundations bodies were buried in a doubled-up position, some partly and others wholly under the walls of the house, to obtain which it is necessary to dig two or three feet deeper.

The only skeletons which I found in the middle of the rooms were those of children buried under the hearths.

I took up one of these hearths, the sides of which were each formed of one piece of hewn stone, the center being filled with a hard cement.

Under this hearth I found the skeletons of two small children doubled in the usual manner.

The pots are found near the heads of adults. Some of these pots contain beads of shell, stone, turquoise, and earthenware, ornaments of stone, human hair, pieces of a nicely woven cotton cloth, braids, twisted cords, charred corn, pumpkin seeds, beans, and various other articles.

I found some small figures of animals not over one inch in length, carved from a greenish stone, very handsome, and highly polished; the stone resembles jade.

The pottery taken from these ruins is of several kinds: First, the rough coil ware, such as is found with prehistoric remains in many parts of the continent. Secondly, those of a finer coiled clay; the coils smoothed, probably, by rubbing with a stone, and with a border worked near the edge. The inside of these specimens are smooth, and a good polish has been given by the use of plumbago, which is worked into the clay. These vessels were used for cooking, many of them being blackened by soot inside and out. Another kind of local ware is made of fine coils of a light color, worked into a great variety of shapes and sizes. Among them are some very large vases.

The greater part of this style of ware is dented with

FIG. 3.

a sharp instrument, and worked into neat geometrical designs without obliterating the coil lines.

A few specimens are of a thick ware, very deeply indented, and resemble carved black oak.

Another kind of ware, peculiar to these ruins, is in color of a bright Venetian red, with black ornamentation in scroll and checker work. It is very difficult to procure perfect specimens of this ware, as they are soft when found, but harden very rapidly when exposed to the air, and, if great care is not exercised not to permit a too rapid hardening, the ware will crack in the process.

This is found in various bowl and pitcher forms.

Another red ware, plain, but very smooth and without ornamentation, is generally confined to various

FIG. 4.

vase and bottle shapes, of very fine, symmetrical proportions. A few very small specimens resemble the common coarse clay ware of the early mound builders.

The chief interest of these ruins is centered in a fine white or very light gray ware, richly decorated with black, a few in brown and other colors. This ware is unique, not being found elsewhere. It is found

FIG. 5.

in quantity about equal to all the other kinds combined. The forms of this ware are very numerous, varying from the delicate Etruscan to the German beer mug, besides bowls, cups, spoons, little fine ornaments, many conventional shapes of animals and birds, such as ducks, turtles, and grotesque figures; others like little shoes, vases, and bottles; and, what is most extraordinary, there are very few, if any, exact duplicates.

FIG. 6.

The accompanying illustrations represent a few specimens of this ware.

Fig. 1 resembles a shoe, with animal's head in front for a handle; the style of ornamentation, arranged like steps with the same forms reversed over them, is one most peculiar to this ware, but varied in an endless number of ways.

Fig. 2 is a bowl 8 in. in diameter and 3½ in depth.

FIG. 7.

A vase (Fig. 3), with fretwork neck, and the body of a scalloped pattern and symmetrical form, is a beautiful specimen of this ware.

Fig. 4, a jug, is 8¼ in. in height, 8 in. body diameter, of a handsome globular form, intricately decorated with an exquisitely balanced distribution of black and white.

Fig. 5 is a double-ended vessel, with a neck orna-

mented in checks, and the body decoration suited to the form of the vessel.

Fig. 6 is in form like a modern flower pot, 6 in. in depth, and 8½ in diameter at the top, decorated in black and white designs upon a white ground.

Fig. 7 is a low gourd-shaped mug, of the ware which I have mentioned as so hard to procure undamaged, remarkably neat in design and ornamented in red and black.

Fig. 8 is a ladle, 10 in. in length and 2 in. in depth. Ladles, both large and small, are frequently found with

FIG. 8.

this pottery. All are made of the fine white and black ware.

The smaller ones were probably used as spoons; some are quite small, that represented in Fig. 9 being only 6 in. long and ¾ of an inch deep.

The white and black ware is all glazed. It is generally believed that the ancient American pottery was never glazed; here we have glazed prehistoric ware, an art which appears to have been lost in later times. While some have been inclined to doubt the fact that this ware is glazed, Prof. Frederick Starr and other eminent ethnologists pronounce it genuine "fire

FIG. 9.

glaze" of the salt order. The ware is light, thin, and strong, firing giving it a surface like enamel; some pieces, defying the decay of time, are nearly as bright and clean as when new.

THE TELL EL-AMARNA TABLETS.

By the REV. THOMAS HARRISON, F.R.G.S.

THE Tell el-Amarna tablets, after some years of patient study on the part of experts, are now known to consist for the most part of a political correspondence of great interest and importance between kings, governors and officers, who formed their plans, struggled with their difficulties, fought their battles, and made their exit from the worry and work of life 3,370 years ago. These letters are inscribed on brick tablets, and, as a rule, occupy both sides of the tablet. With two exceptions, which are from Hittite princes and in their language, the letters are written in an ancient form of the cuneiform script. They were found in the year 1887 by an Egyptian peasant woman amid the ruins of the palace of Amenophis IV., or Khu-en-Aten, at a place now known as Tell el-Amarna, midway between Minieh and Assiout, on the eastern bank of the Nile, about 180 miles by river south of Cairo. The tablets number 330. The writers of the letters from Palestine (178 in number) are Amorites, Phenicians, Philistines, and others, and they are addressed to the Pharaoh of Egypt and certain of his officials. At the time of this correspondence (about 1480 B. C.) the power of Egypt was waning and Egyptian garrisons were being withdrawn from Palestine in face of successful attacks by the kings of Armenia, Nii, Shinar, with the Hittites of Merash and Kadesh on the north, and of equally successful attacks by the *Abiri* (Hebrews) on the south. The letters state that the Abiri came from the desert and Mount Seir. Major Conder affirms that "the date of the letters is exactly that which is to be derived from the Bible (I. Kings vi. 1) for the Hebrew invasion, according to the Hebrew and Vulgate text, and it agrees with the fact that the Egyptian conquests made by the XVIIIL dynasty (1700 to 1600 B. C.) had been lost when the XIX. dynasty acceded." It is certainly very interesting to find in the letters the names of Japhia (Josh. x. 3, one of the kings killed by Joshua) and most probably that of Adonizedek, king of Jerusalem; while the name of a king of Hazor is read as Jabin (Josh. xi. 1). It is also pointed out that the name of the captain of Jabin's host is, Egyptian, Sisera or Ses-ra, meaning servant of Ra.

In most of the letters from the kings of the cities of Phenicia and Northern and Southern Palestine the appeal is ever one for Egyptian troops to enable them to hold their cities for the Pharaoh, to whom they seem to have appealed in vain. The earlier letters of brave Ribadda, the king of Gebal (now Jubeil, north of Beyrout), usually begin with the following salutation, which is given as a specimen of such salutations at that time: "Ribadda of the city of Gebal of his Lord, the King of many lands, the prosperous King, Baalath of Gebal, she hath given power to the King my Lord. At the feet of the King my Lord, my Sun seven times seven times I bow."

The salutation of the later letters becomes shorter and less ceremonious, as Ribadda felt that he was being left to his fate. Here is one of his appeals for help: "I have been hard pushed. Help speedily, O King my Lord. . . . Soldiers and chariots, and you will strengthen the chief city of the King my Lord."

And what can be more pathetic than this, coming from that same brave heart, which has now for more than 3,300 years ceased to trouble itself about chariots and men of war and Pharaohs who could not or would not come to his aid?

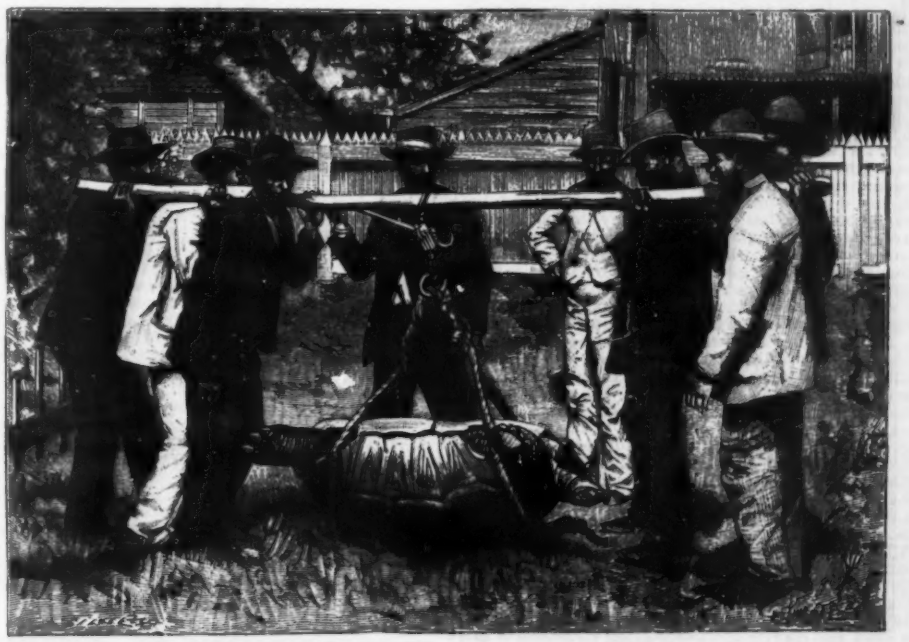
"And will not my Lord hear the message of his servant? Men of the city of Gebal, and my child, and a wife whom I loved, this son of war, the son of Abdasherah has seized; and we have made a gathering, we have searched; and I cannot hear a word spoken about them. I am doing my duty to the King my Lord, and once more, dispatch thou men of garrison, men of war, for thy servant, and will you not defend the city of the King my Lord?"

On May 14, 1892, a cuneiform tablet was found by Mr. Bliss while excavating at the old Amorite city of Lachish, in Judea, in which the name Zimridi twice occurs. From the Tell el-Amarna tablets we learn that Zimridi was governor of Lachish, and, moreover, in a tablet from the king of Jerusalem to Amenophis IV., we are informed of the death of Zimridi at the hands of the servants of the Pharaoh just named.

Many matters of great interest in connection with these tablets can find no mention within the limits of this paper. It may be added, however, that the topographical value of these letters is very great; and also that the evidence which they afford as to the Hebrew conquest of Palestine under Joshua is in favor of the Bible chronology (Acts xiii. 20; I. Kings vi. 1) and against that of Dr. Brugsch and Bunsen.

A GIGANTIC LAND TURTLE.

THE accompanying engraving, from *La Nature*, represents the weighing of a gigantic land turtle captured



WEIGHING OF A LARGE LAND TURTLE ON THE ISLAND OF MAURITIUS.

on the Mauritius Island. The animal, which was a male, was 8¼ feet in circumference. The plastron presented a concavity of 3¾ in. The sternum was 30 in. in length by 27 in width. The carapax, in following the curve of the back, measured 4·4 ft. from end to end and 4·7 from side to side. The tail was provided at its extremity with an appandage resembling the horn of an ox. The weight of the animal was exactly 352 pounds.

THE BEAVER AND HIS WAYS.

By S. L. CLAYES.

WHILE the powerful nation which occupies the greater and most desirable portion of the continent of North America has selected the eagle, kingly and rapacious, to serve as her emblem, her neighbors on the north have chosen the humble beaver, with its peaceful temper and patient, plodding, industrious life, as the symbol of their country and its people. Now that the Canadians as individuals are so rapidly forcing their way among us, and the question of annexing them as a whole is being discussed, we may well afford to give a short time to the consideration of this most interesting animal by which they have typified themselves.

The beaver belongs to the order of rodents, or gnawing animals—a very large and varied order—the members of which are nearly all pure vegetable feeders. The beaver is first cousin, once removed, to all the squirrels; he is also a near relative of the rats, whom he so greatly resembles in person that at a little distance he might almost be thought a rat of giant growth. But when more closely examined he will be found to possess distinguishing marks so pronounced that it would be impossible to mistake him for any other animal of the order. His greater size, his thick, broad head, his wide, flattened, scale-covered tail are sufficient to place him beyond a question. The veriest novice, as well as the man of science, would know at once that it could be nothing but a beaver.

When full grown, a beaver will weigh from thirty to fifty pounds, seldom measures less than two feet, and sometimes three feet, from point of nose to root of tail, and the broad, scaly tail adds at least another foot in length. One which was killed at Great Slave Lake, and preserved in the museum of the Zoological Society, is in length of head seven inches, head and body forty inches, and scaly part of tail eleven inches. The beaver wears a robe of richest fur, which like that of many animals is composed of two kinds of hair; the longer is coarse, though glossy, generally of a rich chestnut color, but sometimes black, while the inner coat is of the very finest, dense, soft, silky, ash-colored fur. But it must be owned that underneath this royal robe his shape is far from graceful. In fact, he is thickset and clumsy, broadest at the hips, whence the body tapers sharply to the tail. The head is somewhat like a cat's, though with less of grace than pussy's has, being very broad and blunted at the nose, with eyes small, though bright, and little, short, rounded ears. The paws have each their full complement of five toes; those of the fore feet are short, quite distinct and well separated, but the hind ones are long and spreading, and are webbed so generously that the membrane extends even beyond the roots of the nails. In this particular the beaver is specially distinguished, being the only animal known in which this peculiarity of webbing is found—resembling as he does, in fact, a terrestrial creature in front and an aquatic one behind. In swimming, the fore feet are carried close to the body, remaining quite motionless, while the paddling is all done by these powerfully webbed ones, aided perhaps by some sculling motion of the tail; and they are sufficiently strong to propel their owner through the water at a considerable rate of speed.

The tail is broad, flat, oval shaped and paddle-like. It is from twelve to fourteen inches in length, four or five inches broad, and not much over an inch in thickness. The older writers regarded this oddly-shaped tail as a sort of mortar board and trowel, used for the conveyance and placing of mud in the construction of their buildings, and as a mallet for the pounding in of stakes. Later observation shows this to have been a wholly erroneous conjecture. The tail serves, like that of the kangaroo, as a sort of fifth leg, and steadies its owner when sitting upright at his work; and he also uses it as a rudder and scull when swimming in the water. In eating, he always sits upon this tripod of hind feet and tail, using the fore paws to daintily hold his food and convey it to his mouth. While the whole flesh of the beaver is regarded by the Indians and frontiersmen as toothsome and delicious, the tail is looked upon as a special *bonne bouche*, they declaring it to possess meat of every known flavor, a part of it even resembling the cooked white of an egg.

The animal possesses in the greatest perfection the organs of sight, hearing and smell, is daintily neat in its habits, is easily domesticated, and makes an affectionate and interesting pet. The incisors, or cutting teeth, are broad, flattened and remarkably strong, exhibiting in a marked degree the characteristics belonging to the order of gnawers. Their front is of a peculiarly hard enamel—which in the beaver is of a bright orange color—the back part of some softer substance, which, as it more easily wears away, produces a chisel-like edge of great sharpness and power. Indeed, so perfect an instrument are these teeth that the Indians, before they became possessed of files, fixed them in wooden handles and used them for cutting the bones and horn with which their weapons were tipped. With these sharp and powerful teeth the beaver is not only capable of gnawing through the trunk of a tree eighteen or more inches in thickness, but will pare an apple as smoothly and neatly as it can be done with a knife. The beavers choose for their food the barks of trees—seeming to prefer those of the birch, poplar and willow—the roots of water lilies and other aquatic plants, varying the *menu* in summer by eating the leaves of various plants and such berries as they find in the vicinity of their homes. In captivity they will eat with relish bread, milk, sugar, fruit and many vegetables and succulent roots.

The beaver carries in its groin two little pouches containing a substance of highly pungent odor, called castoreum. Its use in the animal economy is still undetermined, but it was greatly valued in medicine among the ancients, and even more modern physicians have not disdained its use. Its peculiar smell is so attractive to the beaver themselves that this fact is

taken advantage of by the trappers, who use it with great success as a bait for their traps.

The beaver ordinarily brings forth its young in the month of May, giving birth to from four to eight kittens—five being the average number. The tiny beavers are the quaintest of babies, with broad cutting teeth well developed at birth, big, heavy heads, flat tails, fine fur, soft as down, and as yet showing no trace of the veil of long, coarse hair beneath which it is hidden at a later day. The cry of the baby beaver is so human, so nearly identical with that of an unweaned child, as to have often deceived those wise in woodcraft ways. The young are cared for in their family circle until they have attained the age of two years, when they are turned adrift, and from that time forward are obliged to shift for themselves.

The beaver may be classed among the nocturnal animals, and is very aquatic in its habits, seldom wandering far from the lake or river where it makes its home. It is mild and peaceful in its temperament, but, while living in families, is rather inclined to be exclusive in its social life, seldom associating with others than its own immediate relatives. During the summer months beavers are occasionally found living alone, but some time in August they again reunite in families, which continue unbroken at least until the following June. At this time—the latter part of summer—their busy season opens. All appear possessed with the necessity of providing against the inclemency of the coming season of cold. Every member of the community—be he young or old—is pressed into service and lends a willing aid in the work of building or so repairing the dams and dwellings as to render them fit for winter use. The houses, as well as dams, are built in the water, preferably running water, because the beaver can utilize its force to float his timber and help him in his work. He always chooses a spot where the water is so deep that it will not freeze to the bottom in winter, otherwise the entrance to his house might be obstructed, and he would find himself unable to go in and out. When the stream is too small to insure the proper depth, he constructs a dam which differs in shape in accordance with the necessities of his work. Where the current is slight, one running straight across will serve, and such he builds; but should the stream flow swift and strong, the dam is curved against it, and is as carefully calculated as if the beaver were a trained engineer to curve the most just where the pressure is greatest, as well as to take advantage of any natural aid of rock or islet lying in its path, which may be utilized in its construction. The materials for his work are drift-wood, logs of birch, willow, poplar, soft maple, stones and mud. To procure the logs the beaver approaches a tree that seems to him suitable for his purpose, taking care to choose one higher up the stream than he intends to build, sits down before it upon his haunches and begins to nibble, or rather gnaw, gradually circling around the tree, cutting it equally on every side into a sort of hour-glass shape. Should he become weary in his wood-cutting he may give himself a brief respite and slip into the water for a refreshing bath, but it is soon over, and he is at work again more vigorously than he was before. When nearing the center he manages with all the nicety of a woodman, testing repeatedly with his paws to judge how nearly ready the tree is to fall, and, at length, by a clever and vigorous bite or two on the side toward which he wishes it to fall, produces the warning crack; and then, with a clumsy dexterity, he manages to shuffle out of the way as at last it goes over. Bringing the useful teeth again into service, he cuts up the body of the tree into such lengths as he deems convenient, cuts off the larger branches and strips away the smaller twigs, which last, with the bark peeled from the trunk and larger limbs, he carefully reserves for winter food. Finally, using teeth, chin and paws in the work, he pulls and drags the timbers to the water, which floats it to the place where the dam is being constructed. After the timbers are placed, clods of earth, stones and smaller sticks are added, and at last every interstice is filled with mud and clay, and the resulting structure is one of great solidity and strength.

The houses are built in a similar manner. They are circular, closely resembling in shape the snow houses of the Esquimaux, are six or seven feet in diameter, and three in height, inside measure, but are quite double this size upon the outside, owing to the immense thickness of the walls. The entrance is from the water, by a passage which opens near the middle of the floor; and their beds or nests—and each beaver is fastidious enough to possess a separate one, sacred to his use alone—are ranged around the edge of the hut. Here they sleep, each lying as close as he can get to the outer wall. Beaver houses are not particularly symmetrical and are much less carefully constructed than the dams. One observer has compared them in appearance to enormous crows' nests turned upside down in the water. They are, however, made very thick and strong, being quite capable of resisting the attacks of wolves, or the still more dreaded wolverine, the most deadly enemy, after man, which the beaver has to fear. The huts are plastered upon the inside with mud, although the work is done rudely, and each affords a safe and warm shelter for the little family of from four to twelve individuals which inhabits it. There is never any means of communication between the different dwellings, even where, as is sometimes the case, there is more than one apartment underneath a single roof. Each family keeps strictly to itself, entering, if they ever do enter, their neighbor's house only by the front door. The family residence is used by its inmates as a sitting and sleeping room alone, so to speak. The beaver, rather oddly, refuses to regard his home as being in any degree suited to the purposes of a banqueting place, and insists upon choosing some hole or burrow in the neighboring bank, which shall serve him and his family as a refectory.

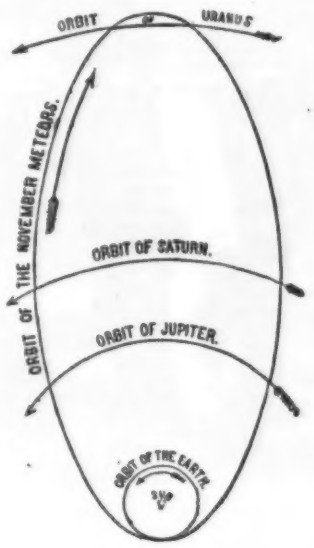
We are indebted to Herodotus for the earliest notice which we have of the European beaver. He alludes to it as living upon the Don; says that its skin is used for clothing, and mentions the precious castoreum which it yields. Reference to the animal is also found in the writings of Aristotle. Pliny speaks of it at length. It once existed in the British Isles, but it has long since become extinct there. It formerly ranged over the greater part of the North American continent, from the extreme north nearly to the Gulf of Mexico; but it has now become rare, retreating, or rather disappearing, as have so many of our other native animals, before the destructive practices of the hunter and the trapper. It is now found in abundance only among those lakes and rivers which lie in the northwestern and more unsettled portions of the continent. It also still lives and flourishes in some parts of Siberia and Kamchatka. Societies of beavers were found in France till the end of the Middle Ages. In 1801 there was still a colony on the Elbe, and in 1830 there was another on the Nutta, one of its affluents.

When taken at an early age the beaver soon becomes very tame and much at home in the house of his host. They are so popular as pets that one or more of them is found at nearly every trading post in the Northwest. Neither is it uncommon to find one running about an Indian lodge, playing with the dusky children, and living with them on terms of such perfect equality as sometimes even to share the maternal breast with the youngest papoose. In captivity they occasionally appear moved by their instinct, or shall we rather say by the spirit of heredity, to build dams across the corner of the room where they live, or the cage in which they are confined. This last, by the way, must not be made of wood, or it will soon be found of slightest use as a barrier between the beaver and liberty, his serviceable teeth biting their way with ease and speed through anything softer than metal. In the Museum of Natural History in Paris during one hard winter a beaver was confined in a cage that was so exposed as to fail to protect him from the inclemency of the weather. One night when the snow was falling and drifting into his cage, the beaver made use of the sticks off whose bark he had supped to aid him in building a screen-like wall. He wove them as a basket-maker might, in and out among the open bars; then collecting all the straw and bits of vegetables that he could find among the debris at the bottom of his cage he so deftly filled up every vacant space as to effectually protect his chamber against the snow and cold, and slept snug and warm behind his barrier in the midst of the storm.—*Popular Science News.*

THE LEONIDS, OR METEORS OF NOVEMBER 13.*

By DANIEL KIRKWOOD.†

WITHIN the memory of persons now living, shooting stars were regarded as gaseous matter generated in the atmosphere. Their true nature was wholly unknown,



and works on astronomy made no attempt to account for their origin.

The most brilliant display of these phenomena recorded in history occurred on November 13, 1833. Few persons of the present day remember the scene as then witnessed. A shower of fire, indeed, is not to be forgotten, but the interval of sixty years has left the number of spectators small. Throughout a large part of North America the atmosphere on the night of the display was remarkably clear. The unusual frequency of meteors was noticed as early as eleven o'clock on the night of the 12th. As the night advanced their numbers rapidly increased, till all attempts to count them were entirely abandoned. Thousands of observers, from Greenland to Florida, from Behring's Strait to Panama, looked on with increasing wonder from midnight to daylight. The meteors appeared to radiate from a particular point in the constellation Leo. Their apparent magnitudes varied from the smallest visible particles to that of the full moon. Their brilliancy was such that persons sleeping in rooms with uncurtained windows were aroused by their light. Occasionally one of the larger masses separated into parts, and some fragments are said to have remained visible for several minutes. In some parts of the country the ignorant and superstitious were completely terrified, imagining that the last day was about to break upon the world. The wonderful appearance presented a new problem for scientific investigation. Shooting stars had indeed been seen in all ages of the world, but they had been looked upon as simply atmospheric phenomena. It was now seen, however, that the meteors of November 13 did not move in harmony with the ancient theory. A new discussion of facts was accordingly undertaken by prominent astronomers. Among its leaders were Professors Olmsted and Twining, of Yale College, Olbers and Erman, in Germany, with others no less eminent both in Europe and America. The origin of meteoric astronomy as a science dates from this epoch. It was remembered by a few persons that at the same date in the previous year, 1832, an unusual number of meteors were seen, though the display was much less brilliant. It was perceived, therefore, that this coincidence of dates could be best explained by supposing a train of cometary matter to cross the earth's path at the point passed by it on the 13th of November. The fact was also recalled that Humboldt had witnessed a similar display, though less remarkable, in South America November 12, 1799, thus confirming the theory of a cometary or nebulous intersection of the earth's orbit, and indicating a period of thirty-three or thirty-four years. The *American Journal of Science* for 1864 contains the elaborate researches of Professor H. A. Newton in regard to former displays of the November meteors. The list extends backward through a thousand years, including the dates 1698, 1602, 1533, 1366, 1202, 1101, 1002, 934, 931, and 902. The shower of 1366—almost equal to that of 1833—is thus described in a Portuguese chronicle quoted by Humboldt:

"In the year 1366, twenty-two days of the month of October being past, three months before the death of the king, Don Pedro (of Portugal), there was in the heavens a movement of stars such as men never before saw or heard of. At midnight, and for some time after, all the stars moved from the east to the west; and after being collected together, they began to move, some in one direction and others in another. And afterward they fell from the sky in such numbers and so thickly together that as they descended low in the air they seemed large and fiery, and the sky and the air seemed to be in flames, and even the earth appeared as if ready to take fire. That portion of the sky where there were no stars seemed to be divided into many parts, and this lasted for a long time."

With the average time of revolution (33¼ years), the perihelion being at the earth's orbit, it is easy to calculate the meteoric path around the sun, as represented in the figure.

The return of the November meteors has been either after intervals of thirty-three years or after some multiple of that period. A return in 1866 or 1867 was accordingly predicted. The shower was witnessed it Europe in the former year and in America in the latter. The fact that the phenomena extend over two or three years merely indicates the gradual diffusion of the meteors along the orbit, so that several years are required for the entire cluster to pass any particular point of the path.

Origin of the Meteors of November 13.—In December, 1865, less than a year before the great showers of the November meteors, a comet was discovered moving in the same path, in the same direction, and having the same period. This coincidence could not have been accidental. It was accordingly concluded that the meteoric cluster was derived from the comet; that the latter is undergoing the process of dissolution; that the cometary matter is being slowly distributed around the orbit; that the comet will thus finally disappear and manifest itself only as yearly showers of the November stream.

Height of Meteors.—The observations of Professors Newcomb, Harkness and Eastman, of the United States Navy, on the 12th, 13th and 14th of November, 1867, decided, at least approximately, several questions of importance. A line from Washington, D. C., to Richmond, Va., furnished a convenient base for the determination of parallax. It was found that the meteors first became visible at an average altitude of seventy-five miles; the maximum probably not much exceeding one hundred miles. The average height at extinction was about fifty-five miles; the latter elevation being greater than the previously estimated height of the atmosphere. As the meteors of this swarm have retrograde motion, or, in other words, meet the earth in its path, they have the extraordinary relative velocity of forty-four miles per second. This rapid motion, even in an atmosphere extremely rare, produces an intense heat of the moving particles. The brilliancy of many was very remarkable. In a majority of instances visibility lasted but a fraction of a second.

During the thickest part of the shower (1867) the meteors were counted at the rate of fifty per minute, or one nearly every second. These small bodies are burned up or dissipated long before reaching the earth's surface. The results of combustion, however, may, at least in part, be ultimately deposited as solid matter. The weight of the individual meteoroids cannot be given with any degree of accuracy. They are known, however, to be very minute, and Professor Newcomb remarks that if we assume a mean weight of a single grain, "the entire mass of the stream may be rudely estimated as equal to that of a mass of iron four hundred feet in diameter."

Such has been the development of meteoric astronomy. A *pseudo*-science of atmospheric phenomena, it has within three-quarters of a century been transferred to the heavens. From tracing the "mystic dance" of *ignes fatui*, it has risen to trace the curves of comets and of stars. In determining the cometary period, Professors H. A. Newton, of Yale College, and J. C. Adams, of Cambridge, England, held each a conspicuous place. The former showed the period to be 180·05 days, 185·54 days, 354·62 days, 376·5 days, or 33·25 years. He showed, moreover, how it was possible to determine which of the five periods is the correct one. This crucial test was applied by Dr. J. C. Adams, who, by an elegant analysis, proved the last named period to be the true one.* Prof. Newton has traced the history of the Leonids for a thousand years—from A. D. 900 to the present time. Its ancient track is more obscure, but an occasional glance may perhaps be caught as it moves down successive ages. Were the cometic matter uniformly distributed around the orbit, a display would be an annual occurrence. A few sporadic outriders of the cluster are sometimes found, and, rarely, larger groups have been noticed. Two have been specified by the present writer.† *When may we expect the next shower from this celebrated cluster?* The average period, as we have seen, is 33·25 years, and the display is continued through at least three consecutive years. We may, therefore, expect it in 1899, 1900, and 1901. It former times it not infrequently escaped observation. The meteoric fall some-

* Communicated by the author.

† As the closing years of the nineteenth century are to witness a display of the November meteors, the following paper may have a timely interest.

* *Monthly Notices* R. A. S. for April, 1867.

† See Payne's *Sid. Mess.*, Oct., 1865. Also *Chambers' Astr.*, vol. i., p. 622.

times occurred in the daytime, sometimes in cloudy weather, and sometimes over the ocean, or over uncivilized countries. The probability of such failures is now less than in former ages. In short, if we live and retain our sight for the next six or seven years, we shall, no doubt, have the pleasure of seeing at least one grand meteoric shower.

It will also be highly interesting to astronomers to watch the comet of 1866, the body associated with these November meteors—the comet moving with them, and from which they are derived. As it has for centuries been subject to a wasting process, it was doubtless larger in ancient times than at present. In 1366 and at some other returns before the invention of the telescope, it seems to have been seen by the naked eye. The meteors were less widely spread, and, of course, less frequently seen.

THE METEOR COMET OF 1866.

Tempel's comet of 1866 was not visible to the naked eye. It is to be remarked, however, that the apparent magnitude at any return must depend on its relative position with respect to the earth, and also that for a thousand years or more it has been undergoing the process of gradual dissolution. It was a naked-eye comet in 1366 and 868. Other dates also correspond with remarkable exactness to those at which the maximum cluster passed perihelion. Oppolzer's period is 33·176 years, and Newton's for the associated meteors is 33·25 years. The striking agreement of dates at which the maximum cluster passed the perihelion is thus represented :

From 1366	to 1866	15	periods of	33·28	years.
" 1266·8	" 1366·8.....	3	"	" 33·33	"
" 1133·8	" 1266·8.....	4	"	" 33·25	"
" 1067·4	" 1133·8.....	2	"	" 33·20	"
" 1000·9	" 1067·4.....	2	"	" 33·25	"
" 868·1	" 1000·9	4	"	" 33·20	"
" 834·8	" 868·1.....	1	"	" 33·30	"
" 668·4	" 834·8	5	"	" 33·28	"
" 602	" 668·4	2	"	" 33·20	"
" 436	" 602	5	"	" 33·20	"
" 336	" 436	3	"	" 33·30	"
" 269·7	" 336·1.....	2	"	" 33·20	"
" 69·7 (?)	" 269·7.....	6	"	" 33·30	"
B. C. 295 (?)	" 69·7	11	"	" 33·20	"

The mean length of the 65 periods included in the foregoing list is 33·25 years—Newton's period of the meteors; or, if we reject the comet of 295 B. C. as doubtful, we have 54 periods of 33·26 years.

The phenomena of the Leonids fix the dates at which the maximum cluster intersects the earth's orbit, and hence the time of perihelion passage may be inferred. They indicate also what parts of the ring are destitute of meteoroids; what parts are thinly, and what more densely filled with meteoric matter. A separate group of Leonids has thus been found preceding the main cluster twelve or thirteen years.* An ancient display from this secondary cluster is given by Quetelet, *Sur la Physique du Globe*, p. 290. The date was A. D. 288, September 28. A phenomenon from this cluster is also given by Hind for 855 and again in 856. Another, 1787, is given in Humboldt's *Cosmos*, vol. iv. Later space showers are mentioned by Chambers. "It is thus that highly important consequences may be expected to be traced from these and similar investigations and discussions; indeed, the subject may perhaps fairly be deemed an inexhaustible one, for a few coincidences having been ascertained, more will be sure to follow as observations multiply and research extends."† — *Astronomy and Astro-Physics.*

THE RECENT ECLIPSE OF THE SUN.

THE annexed photographs of the total eclipse of the sun on the 16th of last April were taken by Major Marshall, of the West India Regiment, at Bathurst, and presented recently in the London *Daily Graphic*. There was a slight haze at the time, but not sufficient to interfere with the observations. The corona (the luminous aureole surrounding the sun) was bright and evenly distributed, an appearance which is characteristic in eclipses which occur at a time of maximum sun spot activity (recurring every eleven years), such as the present. At times when sun spot activity is slight, the corona generally exhibits four huge wing-like appendages. On the present occasion, however, the corona was very evenly distributed round the dark moon—that is to say, there were none of the great extensions along the equator which were seen in 1878 and 1889. The light of the corona was very bright, and the lamps which had been provided for the use of the observers during totality were quite unnecessary. Indeed, it was only dark enough to render visible some of the brighter stars.

THE RECENT ECLIPSE OF THE SUN, AS PHOTOGRAPHED BY MAJOR MARSHALL AT BATHURST, WEST AFRICA.

(The image in the center photograph is partly out of the field of the telescope.)

* *Chambers' Descriptive Astr.*, vol. i., pp. 681-2.
† Chambers.

THE ATMOSPHERE.

A COURSE of five lectures has been recently delivered at the Royal Institution by Professor Dewar, on "The Atmosphere."

In the course of the first one *The Engineer* says the speaker stated that elaborate experimental research has proved that the normal constituents of the air, apart from local impurities, are substantially the same everywhere, whether collected in London, on American prairies, or on mountain peaks, but that the amount of vapor of water in it varies considerably. The presence of fine particles of dust helps to cause this water to precipitate as cloud or fog, so also do variations of pressure, and the presence of sulphurous acid. The minutest quantities of solid particles are sufficient to promote fog on the expansion of moist air; he showed by experiment that the imperceptible metallic dust from an incandescent platinum wire will have the effect, and even the sparking of two electrical terminals.

The carbonic acid in the air caused by fires, the respiration of animals, and other influences, has long been known to have its oxygen set free again by the leaves of plants under the influence of sunlight, but of more recent discovery is the circumstance that the bicarbonates in sea water help in the equalization, by giving out carbonic acid when there is too little of the latter in the air, and absorbing some of it when there is too much.

In his second lecture Professor Dewar showed that particles of matter may be carried long distances by gases; for instance, hydrogen gas charged with particles of sodium will carry them through tubes 3 ft., 30 ft., or 100 ft. long, without perceptible difference, and give a yellow flame when the gas is ignited at the end of the tube. In another experiment the lecturer sent some hydrogen charged with sodium particles up a tube into the bulb, W, Fig. 1, and ignited

FIG. 1

it at K. When through the wires, A B, a glow discharge was produced in W, the sodium particles were thereby blown out of the gas and against the sides of the bulb, which shows that such particles can be cleared out by electricity. It was once thought that the lines in the spectrum of the aurora were due to cosmic dust, but the experiment just described tends rather in an opposite direction; the discharge is connected solely with the gas, and if metallic particles are there, they must be cleared out at once.

He here drew attention to a great glass globe, 4 ft. in diameter, open at its lower end, and which had been standing thus inverted for two days in the theater, to allow the dirt in the contained air to settle. When a beam from the electric lantern was sent through the globe, it was seen that the air inside was free from any floating dirt which would perceptibly scatter the light. He then introduced into the globe some smoke from burning magnesium, and a few electrical discharges from a Wimshurst machine made the particles clear out of the air, and settle upon the sides of the globe.

The lecturer next drew attention to a water barometer, thirty-four times longer than a mercury barometer, consequently more sensitive; its upper end was in the theater, its lower end in the basement of the building. An air barometer, he remarked, is much more sensitive still, as the pressure of a given column of air is more than ten thousand times less than that of mercury. A homogeneous atmosphere five miles high would balance 30 in. of mercury; a millionth of an atmosphere in the air would amount to about one-third of an inch. Here he took a cylindrical metal vessel, connected below with a strong narrow flexible metallic tube; the latter was coated with India rubber, to protect the metal tube from changes of temperature when occasionally touched by the fingers. When the cylinder was hauled up a few feet by a rope, the air inside it at that elevation was heavier than the air outside, and the consequent difference of pressure was made evident by a delicate indicator at the lower end of the tube. The indicator consisted of a little ether in the bore of a small horizontal glass tube, which tube was open to the air at one end and connected with the metallic tube at the other. Hence, when the cylinder was elevated, the additional pressure as compared with the outside air pushed the column of ether in an outward direction in the tube, as made visible to all present by optical projection. When two cylinders with piping were used, and one was raised a few feet while the other was lowered to a corresponding extent, the slight degree of vacuum thus produced in the lower one balanced the slight extra pressure produced by the upper vessel, and the indicator did not move.

In his third lecture Professor Dewar pointed out that the ether indicator just described was as sensitive as a thermopile to small variations of temperature. He fixed a piece of thin India rubber film over the mouth of a little glass funnel, and connected the tube of the funnel with the indicator; when he then held his finger but an inch or two above the rubber film, its warmth caused air in the funnel to expand and the ether column to move. A disadvantage of this indicator is that it has not a fixed zero. He showed that by putting the mouth of the thin flexible metal tube in any position it would show the pressure or the suction of the air outside its mouth. Thus, in bringing the orifice near any part of a rotating vane, it would show where the vane was blowing, where it was sucking, and where regions of calm were present, and thus give information as to the motions of the air near any part of such a rotary appliance. The distribution of pressures near rotating vanes is exceedingly complicated. He then showed some experiments on air blown at high velocities through narrow orifices in nozzles, and how under certain conditions a ball would not be blown away by the air rushing from a nozzle, but would be kept near it and thrown into a state of rotation. By means of blowing apparatus driven by an electromotor, he made a little vertical whirlwind, and upon placing a tray of water some inches below, the water was thrown into a state of agitation, and made some attempts to rise as a water spout. He placed beneath the whirlwind a large glass vessel open at the top, and containing sawdust. The general motions of the particles of sawdust rendered visible the directions of the air currents.

In his next experiment he employed an ordinary vacuum tube, in which he could produce a glow discharge. The lower end of this little tube opened into a large one, perhaps a yard long by six inches diameter, and by means of a powerful pump he kept up a pretty good vacuum in this arrangement, although it was purposely made somewhat leaky by means of a small orifice in the upper part of the small tube. Thus a wind of high velocity and of highly rarefied air was kept up in the tubes. The arrangement is represented in Fig. 2, and the tap at the top was so arranged as to

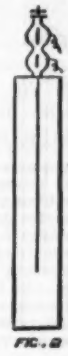


FIG. 2

allow highly rarefied air to rush down the tubes at the rate of something like 10,000 ft. a second. When the little vacuum tube at the top was worked it caused the air to become phosphorescent. By experiment he proved that with hydrogen and nitrogen he could get no phosphorescent effect. To get it, the presence of oxygen was found to be necessary, and then in the dark a phosphorescent glow was seen down the large tube in the position indicated by the dotted line. The light emitted by the air current gave a continuous and not a gaseous spectrum, and he proved by tests that some of the air was transformed into nitrous acid and ozone under the influence of the electricity. Any traces of essential oils in the air, such as those much liked by some members of the community, put a stop to the luminosity, and when once a trace of essential oil gets into the apparatus it is hours before it can be so cleared out as to enable the luminosity to show once more.

In his fourth lecture he put a sphere into rapid rotation, and by means of the apparatus and ether indicator herein previously described, showed that the rotation produced suction of the air at the poles of the globe, and pressure at the equator, and that in a very small area between the two was the region of calms. An annular band paper, a little larger in diameter than the globe, brought over the equator, remained rotating there in the region of the equatorial currents, and looking like a Saturn's ring; by its position it defined the region of equatorial currents.

Professor Dewar stated that of late some important experiments have been made in France, by means of small balloons carrying self-registering meteorological instruments into the higher regions of the atmosphere; he exhibited some of the instruments, also the bamboo cages in which they are suspended, to protect them as much as possible when they come to the ground again. Aluminum has been of great use, because of its light weight, in the construction of these pieces of apparatus. Some of the instruments have been up eight or ten miles, carried by balloons about six yards in diameter, and lifting a weight of about 20 lb. It is easy by such methods to get records as far up as ten miles, but to get records by the same method at a height of twenty miles would involve enormous expense in the dimensions of the balloons. A temperature of —50 deg. C. has been reached by the balloons at a height of ten miles; beyond that, increasing the capacity of the balloon ten times adds but 6133 meters to the elevation. Probably in a few years' time, he thought, it will be possible to take photographs at an altitude of ten miles. Solar radiation gets powerful at such

altitudes, and the direct rays of the sun make the balloon exceedingly hot. These experiments have been made chiefly by M. Hermite.

At an altitude of seventy miles the pressure of the air is but one millionth that of the atmosphere at the surface of the earth, and the older scientific books argued that the deeper we descend into the earth, the greater does the pressure of the air become; they argued that at a depth of forty miles the air would be as dense as mercury, but all that is now known to be wrong. The air has been compressed more than that by artificial means, and it is found that its density never exceeds 1¼ times that of water; it comes to a limiting density, or, in other words, to a limiting volume. If the atmosphere be supposed to be in a state of convective equilibrium, then what takes place in compression will depend upon the nature of the gas. The presence of moisture in air has a great disturbing effect, because as it condenses there is such great evolution of heat, but in the case of dry air some of the facts can be easily ascertained by calculation. In rising in the atmosphere, for instance, at a height of twenty miles we should reach the absolute zero of temperature, but radiation and conduction of heat came into play, and there is no doubt that the upper regions of the air have a higher temperature than it is generally thought they ought to possess.

Solar radiation falls off a great deal at low elevations, and the constituents of the atmosphere exhibit complicated selective absorptions. Gladstone and others have observed the differences in atmospheric bands from sunrise to sunset, and shown that a large proportion of them are due to aqueous vapor, but oxygen and nitrogen have also their special absorptions, and in dealing with oxygen one wants a mile of the gas to study. Experiments are made in laboratories by taking a tube 60 ft. long, and getting in the gas under a pressure of 150 atmospheres. Professor Dewar here exhibited the absorption spectrum of compressed oxygen.

In the course of the lecture he drew attention to the following table of the variations at the surface of the earth of solar radiation:

Solar Radiation.

Zenith distance. Deg.	Thickness of atmosphere.	Intensity of radiation. (Air Dry.)
0	1,000	2·403
10	1,016	2·401
20	1,065	2·395
30	1,155	2·383
40	1,305	2·364
50	1,555	2·331
60	2,000	2·275
70	2,930	2·164
80	5,700	1·868
90	35,000	0·359

THE CONSTRUCTION OF A WATER TIGHT MASONRY DAM.*

By WALTER MCCULLOH, Jun. Am. Soc. C.E.

IN 1857–58 the Croton Aqueduct Department of New York City made a careful topographical survey of the Croton watershed above Croton Dam, with a view to locating all possible sites for dams and storage reservoirs, should such reservoirs be required as the city grew and the demand for water increased. The survey was made under the direction of the late Alfred W. Craven, chief engineer of that department, and covered some 338 square miles of the watershed. Fifteen sites were located as possibilities; but of these some have since been considered impractical for various reasons.

Dams were constructed on two of these sites a few years ago by the Department of Public Works, and one more is now under construction by the same department. Four more are in course of construction by the aqueduct commission, and two have recently been completed by the latter and are now in use; the latter being at "Double Reservoir I," which is familiarly known as Sodom and Bog Brook Reservoir.

This reservoir is termed double, as it is composed of two basins connected by a 10 ft. circular tunnel, 2,000 ft. long, through which the overflow of the larger passes into the smaller before any waste takes place over the spillway. The smaller, or Bog Brook basin, has an inadequate watershed of only 3½ square miles, while its storage capacity nearly equals that of the larger. The combined storage capacity of the two basins is practically nine and one-half billion gallons.

Sodom Dam, the one which impounds the water in the larger of the two parts of reservoir "I," is built of masonry throughout, but Bog Brook Dam is an earth embankment with a rubble core wall.

Sodam Dam is situated near the village of Brewsters, in Putnam County, New York, on the east branch of the Croton River, 18 miles above the present Croton Dam; is 54 miles from New York City, and 2 miles from the Connecticut State line. It spans a narrow gorge only 500 ft. wide at coping line, 78 ft. above the river bed, and has behind it 73·42 square miles of watershed.

The aqueduct commission, in August, 1886, sent a party into the field to sink test pits and make borings at the proposed site, to locate the underlying rock and to determine its character. Upon information thus obtained a location for the dam was fixed upon which crossed the valley at about right angles to the stream (see Fig. 1) and which differed but slightly from that contemplated in previous surveys made by the Croton Aqueduct Department and the Department of Public Works.

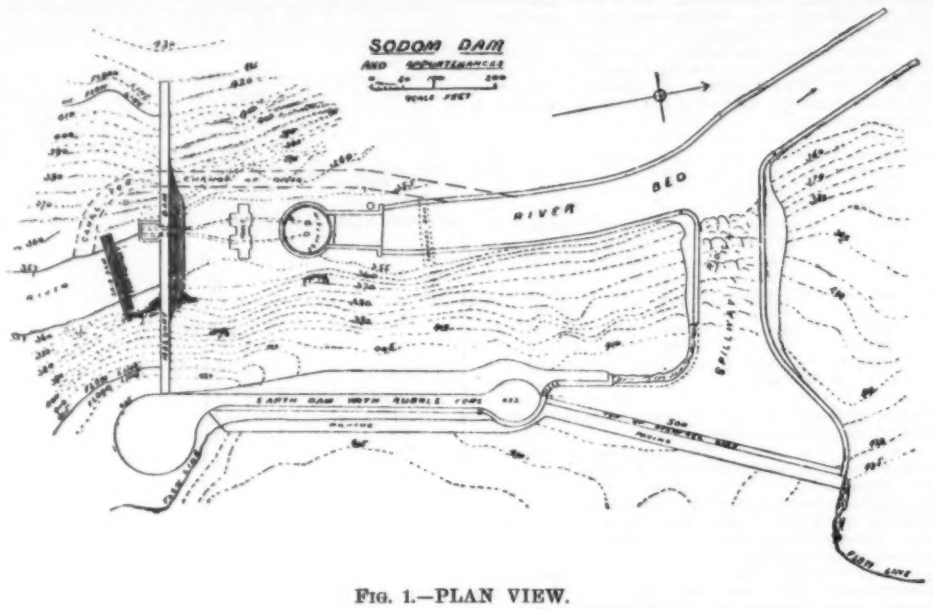


FIG. 1.—PLAN VIEW.

On the site adopted, the hill east of the river (the stream flowing north at this point) showed an outcrop of hard gneiss rock which rose quite abruptly for about 30 ft. above the water and at the foot of which were large bowlders, gravel and river drift. The slope back from the top of this outcrop was much flatter, rising 40 ft. in 100, and the rock was covered with but a few feet of soil. On the west side the slope of the hill starts from the river at a rate of 35 in 100, and gradually flattens to about 5 in 100 at the elevation of the top of the dam. The rock on this side was from 4 to 10 ft. below the surface, and was rotten and shaly for a depth of about 15 ft. The river bed was rock, quite solid, with a light deposit of sand and gravel overlying it. (See Fig. 2.)

The hill on the east side of the river is simply a ridge parallel to and averaging 75 ft. above it, which begins about 400 ft. behind the dam, and at the lowest point north of the dam is 9 ft. below the flow line of the reservoir. On top of the ridge an earth dam was constructed, 600 ft. long, with its top at the same elevation as the masonry dam. At the north end of the earth dam is the overflow or spillway dam, a masonry wall 8 ft. high and 500 ft. long, with the lip set at elevation 415.

The waste water, after passing over the overflow wall, flows to the old river course through a channel cut to bed rock and confined between curved retaining walls. (Fig. 1.)

The principal dimensions of Sodom Dam are (see Figs. 2 and 3):

Length at coping	500	ft.
Length at top of foundation (elevation, 347)	340	"
Thickness at foundation	253	"
Thickness at center elevation	23	"
Thickness under coping	12	"
Height at center, greatest	98	"
Height above ground line	78	"
Elevation of top of coping (New York datum)	425.0	
Elevation of flow line	415.0	
Elevation of flood line	419.0	

The greatest batter is on the lower face, changing at five points between elevation 347·0 and 424·0 and varying from a rate of 9·3 in 10 to 2·7 in 10: the total batter is 37·0 ft. The rate of batter on the back face is 1 in 10 between elevation 347·0 and 387·0; from the latter point the wall is plumb to the coping.

Near the center of the structure at the back is the gate house, 37 × 42 ft., upon which a superstructure stands, rising 23 ft. above the dam. In this gate house are the sluice gates, stop-planks, etc., for controlling the discharge through two 48 in. pipes inclosed in, and passing through, the body of the dam.

After the work had been commenced, the cross section of the dam was modified, as shown in Fig. 3, by the additon of 6 ft. in width at the foundation, 3 ft. at center elevation and 2 ft. at elevation 407·0, the top remaining unchanged. This change was thought advisable by the aqueduct commissioners and the engineers as an extra assurance of safety, and was made at the time when the sad details of the terrible disaster at Johnstown, Penn., were fresh in the minds of every one. The change was also a great help to construction in making it easier to hold the facing stones in their places when laid upon a sloping bed of fresh mortar.

The contract for Sodom Dam and its appurtenances was awarded to Sullivan, Rider & Dougherty, December 30, 1887, and ground was broken by them February 22, 1888.

The first problem of importance to be solved was the care of the river during construction. Croton River usually appeared a very calm and modest stream, but in the spring time, or after a heavy rain, the water would rush through this narrow gorge at an astonishing rate, sometimes as high as 250,000 cu. ft. per minute. The floods always came suddenly, raised for about twenty-four hours, and then slowly receded.

Several plans of flumes were submitted by the contractors (the specifications putting upon them the responsibility of handling the water), but were not approved by the engineers, being considered inadequate to the necessity. The plan adopted was the suggestion of the engineer in charge, and consisted in throwing a timber crib dam across the river about 80 ft. back of the dam site, and from this cutting a canal, 26 ft. wide and about 15 ft. deep, into the west side hill, and entering the river again 500 ft. below the dam. Before the completion of the work this plan proved itself to be the proper mode of meeting the situation.

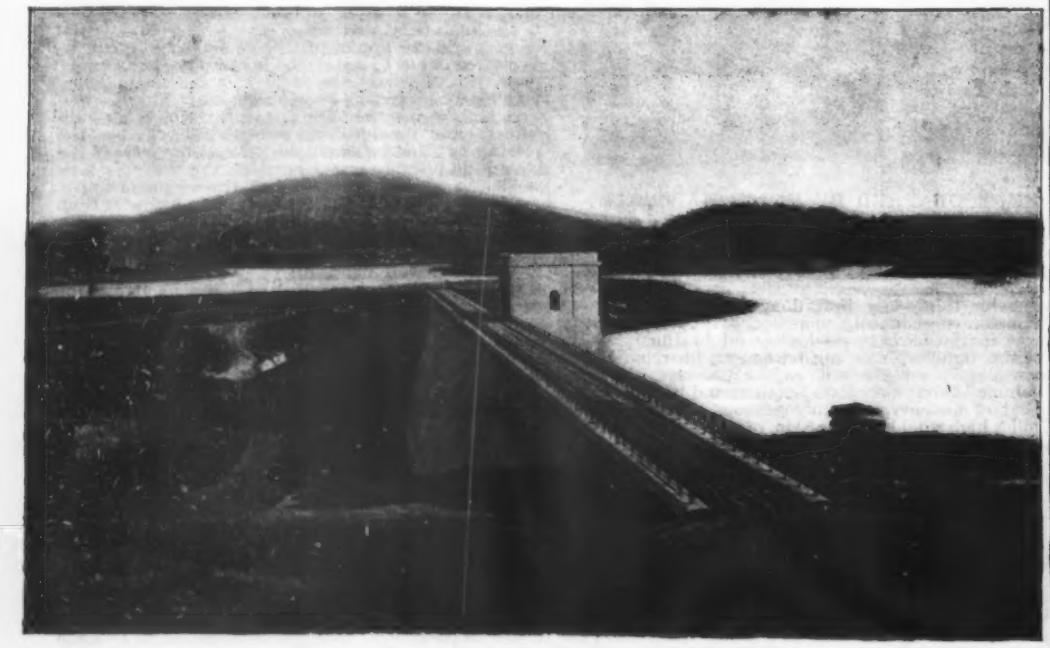
With the river flowing through this new channel the gatehouse and the eastern half of the dam were built to from 25 to 30 ft. above the discharge pipes, and when conditions seemed favorable in the dry season of 1889, the water was turned from the canal and through the pipes, and the remaining half of the dam was then started.

Excavations for the foundation were well under way in April, 1888, and the center 200 ft. section was ready for masonry by the end of August.

In preparing the foundation, drilling was done, both by steam and hand, and light charges of 40 and 60 per cent. dynamite used in blasting till the rock appeared firm. Then all loose seams or shakes were followed up with block holes and black powder blasting and by barring out, until a solid and practically tight bottom was secured. All excavation made in the latter manner was classified as "deep rock," for which an extra price of 50 cents per cubic yard was paid.

The foundation thus prepared was swept with wire stable brooms and washed clean with streams from hose pipes, to insure a perfect union between the rubble masonry and the rock.

When the bottom was ready for the masonry, the



THE SODOM DAM.

* A paper read before the American Society of Civil Engineers, April 5, 1893. From the Transactions of the Society.

plan first used was to fill the pockets, or holes, with a rich Portland cement concrete, forming a series of small level beds upon which to begin the rubble. Concrete beds were discontinued after a two days' trial, because it was found that a surer and tighter bed could be formed of rubble made with small stones.

A large quantity of water made its way through the loose rock above the bottom, and in a number of places through seams in the bottom itself; but in these cases, where the rock was solid, the seams were not followed any deeper. The springs in the bottom would wash the mortar out of the concrete, and in many cases render it worthless; but in making the rubble beds the water could be led round and prevented from doing damage. These streams were nursed about from place to place till finally a small well, 2 ft. in diameter and 1 to 2 ft. deep, would be formed just around the point where the water boiled up. When the mortar about each little well had thoroughly set, the water was bailed out, the well quickly filled with dry mortar, a bed of stiff, wet mortar put on top of this, and on top of all a large rubble stone was placed, and the spring would be successfully squelched.

This process was followed over the entire bottom wherever water had to be contended with, and gave much better satisfaction than could be obtained with the concrete. After the first 6 ft. of the rubble foundation had been placed, it was plain sailing, and the masonry proceeded without further difficulty.

Below elevation 357·0 the entire wall was composed of rubble masonry in 2 to 1 Portland cement mortar; but above 357·0 on the back and 364·0 on the face, it was faced with "facing stone" 30 in. deep and backed with rubble.

Rubble stones varied from a cubic foot to cubic yard in bulk, and in placing them the beds of mortar were made very full and the stone thoroughly shaken to a firm position. The rubble was not carried on in level courses, but was broken as much horizontally as possible, so as to avoid having a straight joint of mortar through the wall.

In filling the interstices the rule invariably followed was to put the mortar in first, then force into it all the spalls it would take, thus insuring perfectly filled joints, and as much stone in the work as possible. Grouting was not permitted at all.

All stones, of whatever size, were thoroughly washed before going on the wall, and were usually wet when placed in the work.

Of the entire bulk of rubble, the larger part was in 1 to 2 Portland cement mortar, the remainder being in 1 to 3 Portland, and a small amount of 1 to 2 American natural cement. All the facing stone and dimension stone masonry is laid in 1 to 2 Portland cement mortar.

The largest quantity of masonry laid in one month was 3,000 cubic yards, with 12 masons and three derricks. The average progress per month was about 1,700 cubic yards.

In mixing the mortar for all classes of masonry, the practice was to mix the sand and cement dry and to wet it on the wall only as fast as it was required. The "dry mixing" was done in large boxes on the ground at the east end of the dam in batches containing three barrels of cement, and when thoroughly mixed, the dry mixture was carried in these boxes to the mortar beds on the dam, and there divided into smaller batches and wet according to the rate at which it could be used up. By following this course the best results from the cement were obtained, as the mortar would be in the work before its first set had taken place, and the necessity of "tempering up" was avoided.

The cement used was "Burham" (English) and "Giant" (American) Portland cements, and "Union" (American) Rosendale cement.

Of the total Portland cement used, only 15 per cent. was Burham.

A very careful test was made of all cements used, under the following requirements:

Tensile strength required in pounds.	One day.	One week.
Portland cement, neat	110	300
American natural cement, neat	35	65

Fineness.	
Portland 80 per cent. must pass through a sieve of	10,000 meshes per sq. in.
Am. nat'l 92 " " "	2,500 " "

Following are some of the results obtained from these tests:

AVERAGE TENSILE STRENGTH IN POUNDS.

BRAND.	Fineness. Average.	TIME SET IN WATER. One day.	One week.	One month.	One year.	Two years.	Three years.	Four years.
Portland.	10,000 mesh.							
Burham, neat	80 pr. ct.	167	429	615	798	700	764	782
" 1 to 2 mortar.		141	258	468	532	632	656	
" 1 to 3 mortar.		169	294	404	520	552		
Giant, neat	82 pr. ct.	140	348	422	682	694	736	771
" 1 to 2		166	280	490	564	680	674	
" 1 to 3		140	234	430	512	572		
	2,500 mesh							
Natural.								
Union, neat	96 pr. ct.	160	240	228	510	542	650	654
" 1 to 2			34	94	304	430	514	522

An excellent quality of coarse, sharp sand was secured from pits on reservoir lands about one mile from the dam; each load had to pass inspection, and all containing any loam were condemned and rejected.

The quarries from which the rubble stone was obtained were about a mile and a quarter from the dam. The stone was transported on double team trucks carrying from 1 to 1½ cubic yards at a load, and making from six to eight trips a day. The rock was a hard and tight-grained gneiss of irregular cleavage.

The facing stones were quarried and cut at a quarry opened especially for the Sodom work, at Towner's, New York, 7 miles away; were brought on cars over the New York and New England Railroad and unloaded at the dam, from which a switch was laid to and connected with the railroad.

These stones, a light bluish gray limestone, were cut rectangular, with "rock face" on exposed face, stretchers being from 3 to 6 ft. in length and 30 in. deep and headers 4 ft. deep. They were laid in regular courses gradually decreasing in rise from the bottom up. The face of the stone is square with the bed, and set with bed normal to the batter.

At first considerable trouble was experienced in holding the stone up to line when set on the inclined beld, but this difficulty was overcome by building the rubble backing up first to about the height of the course, which, when set, could be braced against with wooden blocks and wedges, and the stone held perfectly in place. When the stone had been set for twenty-four hours or more, the blocking was removed and the space immediately filled with rubble backing.

All dimension stone came by rail from quarries on the Brandywine River, at Wilmington, Del., and was an excellent quality of dark bluish granite of a very hard, tight grain.

The plant used by the contractors in building the dam was, with but two exceptions, the "cable" and the "traveler," without novel or especially interesting features.

Three stiff-leg boom derricks with double-drum steam hoisters and two stiff-leg derricks with double-drum horse powers were used, which were shifted from place to place as required.

The "cable," which the writer believes was here used for the first time as part of a construction plant, consisted of a 2 in. steel wire cable weighing 7 lb. per ft., stretched over two towers, one erected at each end of the dam 667 ft. apart and anchored into the bed rock behind the towers. Upon this cable a trolley or car ran which was entirely controlled by a double-drum reversible engine situated back of the west tower.

The cable was swung over the length of the dam, parallel to the center line, and 10 ft. from the back face, and at such an elevation that a car at the center of span loaded to 10 tons would sag the cable to 25 ft.,

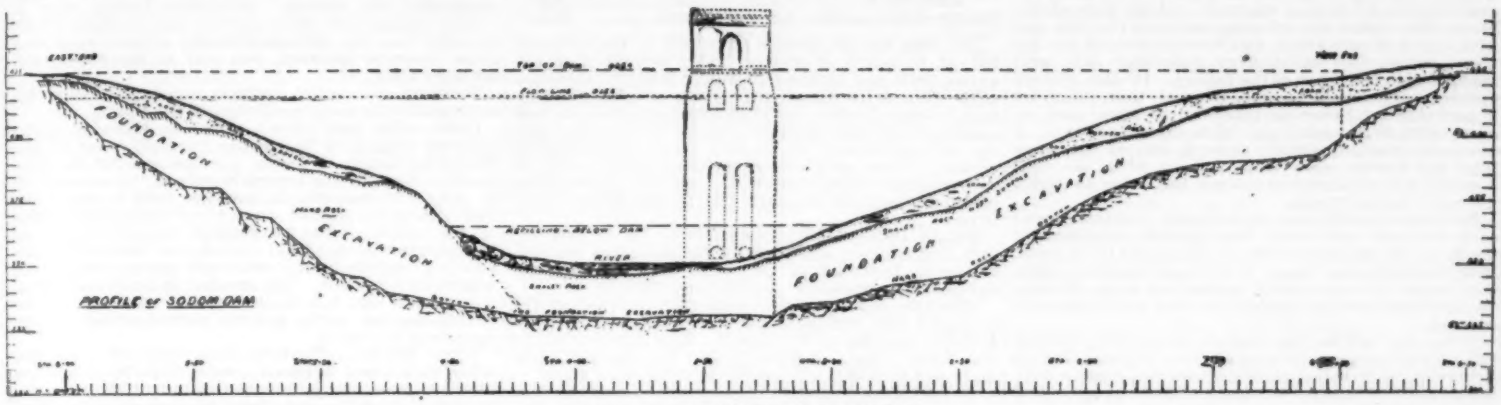


FIG. 2.—SODOM DAM PROFILE.

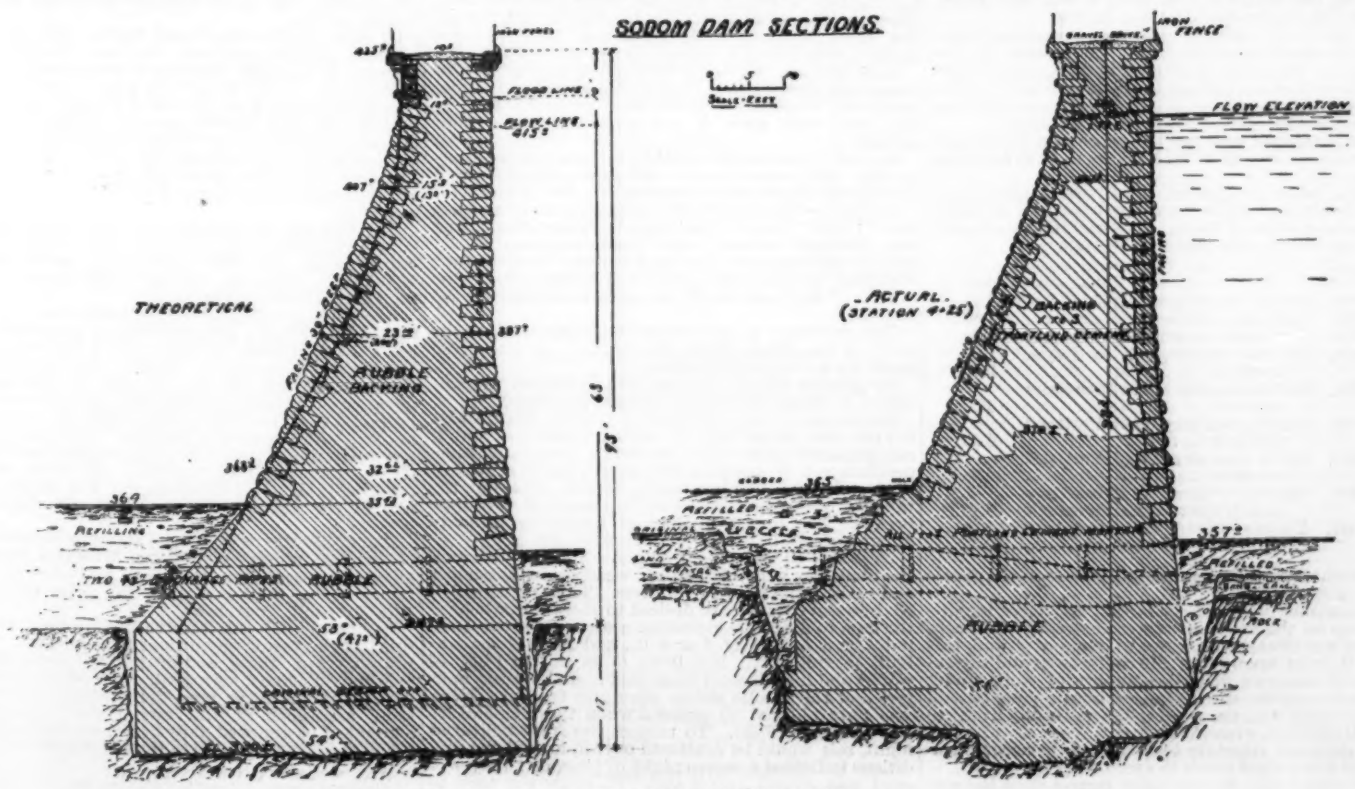


FIG. 3.—SODOM DAM SECTIONS.

and still clear the coping by 5 ft. when the work should reach that point.

The engine was so constructed that it controlled both the movement of the trolley from tower to tower and the raising or lowering of the load. The load could be held at any desired distance below the trolley, and run forward or back, or the trolley could be kept stationary while raising or lowering the load.

With this appliance nearly the whole of the excavated rock was removed, and all material for the masonry was delivered upon the wall. In raising the cable it was drawn up till the sag at the center was about 20 ft. below the supports at the towers. A load would add from 3 to 5 ft. to the sag.

The prime cost of the cable plant complete and erected was $3,750.

In July, 1888, the first cable was raised, from which time it was in constant use till October 29, 1889, when, without warning, it parted at a point 50 ft. from the east tower and fell upon the wall. At the time of the break the trolley was running out from the west end with a load of only 6 tons, and was one-third of the distance across. No satisfactory conclusion was ever reached as to the cause of the failure. In the writer's opinion it was due to unequal wear at that point, for it parted directly over the place where stone and cement boxes were loaded and taken up by the cable. A new cable was immediately secured, and at the same time the towers were raised about 10 ft., so that it would not be necessary to draw the cable so tight, but allow a deeper sag.

No further trouble was experienced and this second cable was kept constantly busy till the completion of the dam. When taken down in the middle of August, 1892, the cable was found to be in an excellent condition, except for a reasonable amount of wear showing on the outside wires; but no broken wires were discovered.

When the wall had reached elevation 395·0, the derricks standing upon the ground were replaced by the "traveler," a traveling derrick mounted upon a 30 ft. trestle and running upon a track of 36 ft. gauge. A 55 ft. boom derrick was erected at the center of the front of the traveling platform and secured by two stiff legs to the back corners of the same, and was operated by a double-drum steam hoisting engine. With this traveler the dam was completed between the points that could be reached by derricks placed upon the side hills.

From start to finish the work seemed destined to delays of all kinds. The celebrated blizzard of March, 1888, was the first serious setback received. Then followed two unusually wet summers, causing a great deal of broken time and consequent loss.

In November, 1889, the most serious of the floods came upon us, and a shutdown for the season was the consequence. All the month of November had been rainy, but on the 28th the climax was reached when in 18 hours the rainfall was 3·8 in., bringing the total fall for the month up to 8·7 in. Eight hours after the rain had ceased, the water behind the dam had raised 10 ft., and in 12 hours had raised 15 ft. and was pouring over the top of the wall in a perfect torrent, notwithstanding the fact that both 48 in. pipes were open and discharging at their full capacity all the while.

Provision had been made for such an emergency by always keeping that portion of the dam directly over the new river channel from 4 to 5 ft. lower than the remainder.

A most serious loss was met with in January, 1889, when John Sullivan, the head of the contracting firm, was removed by death after but a few days' illness. To him had been left entirely the organization of the work and the planning for its future conduct. After Mr. Sullivan's death his interest in the contract was cared for by his executor, Clinton Stephens; P. J. Dougherty, another member of the firm, assuming the superintendence of the work till its completion.

Many other delays, such as strikes at the granite quarry and on the railroads, failure of the railroads to deliver cement and other materials on time, the exhausting of materials, etc., occurred from time to time, so that instead of the contract being completed on December 31, 1889, the specified time, it was not finally finished and accepted till October 31, 1892.

Only one fatal accident occurred during the whole course of construction, and that was caused by the breaking of the cable on October 29, 1889. An Italian mortar carrier was struck on the head by a piece of the trolley and killed. Three minor accidents occurred in which the sufferers required hospital attention.

Labor employed was for the most part foreign, at prices ranging from $1.25 for laborers to $3.50 for stone masons.

The following is a partial list of the quantities of materials handled in the excavation for, and masonry in the construction of, Sodom Dam and the gate house, and the contract price paid for the same:

Quantity. Cubic Yards.		Price.
5,986.	Earth excavation	$0.35
16,260.	Rock excavation	1.50
3,600.	Deep rock excavation	2.00
300.	Rubble masonry, 1 to 2 Am. cement	3.75
23,280.	Rubble masonry, 1 to 2 Portland cement	4.50
6,260.	Rubble masonry, 1 to 3 Portland cement	4.25
530.	Brick masonry, 1 to 2 Portland cement	10.25
776.	Granite dimension stone masonry, 1 to 2 Portland cement.	35.73
4,287.	Facing stone masonry, 1 to 2 Portland cement	10.75

The total bulk of masonry of all classes in the dam is 35,887 cubic yards.

The contract prices for the largest and most important items on the whole work were extremely low, considering the situation and the requirements, and this made it hard upon both the contractors and the engineers to secure a first-class quality of work under such unfavorable circumstances, but it must be said to their credit that the contractors faithfully lived up to their contract, even if at a loss.

The dam now stands in testimony of the accomplishment of the desired result in every respect.

It is impossible to give exact figures upon the cost to the contractor of the different classes of work, owing to accounts not having been kept with this end in view.

The following are some figures on the costs, estimated from such data as could be obtained:

Cement in shed at dam, per barrel:	
"Burham," Portland	$2.51½
"Giant," "	2.31½
"Union," Natural	1.00¼
Rubble stone from quarry on work, including 5 cents royalty, per cubic yard	1.97
Rubble stone and spalls from excavation waste banks	67
Rubble stone, average from all sources	1.26
Facing stone on work, including 15 cents royalty, per cubic yard	9.75
Dimension stone on work, including dressing, per cubic yard	30.08
Rubble masonry, 1 to 2 Portland cement, per cubic yard	4.45
Facing stone masonry, per cubic yard	10.97

The dam was far enough advanced by the winter of 1890-91 to admit of storing water behind it to elevation 390·0, and by the following winter to elevation 415·0. The extra storage supply was absolutely necessary to meet the demand in the summer, since the new aqueduct had been brought into use by this time and the daily allowance to the city had been greatly increased. This early use of the dam caused some inconvenience to construction, and was also a premature test upon the green masonry, but no evil results came from it.

Sodom Dam was finally completed on October 29, 1892, and formally accepted by the aqueduct commissioners on December 28, 1892. The final estimate for dam and appurtenances amounted to $436,499.05.

When the bids upon this work were received on December 7, 1887, Sullivan, Rider & Dougherty's bid was $366,990, they being the lowest. The highest bidder was Miles Tierney, at $584,315, and the engineer's estimate was $540,030; all figured upon the same basis.

The difference between the amount bid and the final estimate is due to modifications made from time to time in the original plans.

As to the water-tightness of Sodom Dam, it is perfect. When the reservoir is filled (with 68 ft. of water behind the wall) many careful examinations have failed to disclose any leaks whatever, either through the wall or under it, or through the rock around the ends in the side hill. "Sweating" at the joints in the facing stone appears at several points only, but not in sufficient quantity to produce a trickle. What moisture there is will wholly disappear on a dry, clear day; but if the day be humid, dampness is visible upon the face of the stone as well as at the joints.

To the question "Upon what did the successful construction of Sodom Dam as a water-tight structure depend?" the writer's reply is: 1st, upon the excellent quality of the material used and the methods adopted in using them, viz., the securing and preparing a solid, tight foundation, the care to have every stone perfectly cleaned with water, the prompt use of mortar after wetting, the perfect filling of every joint with mortar, and the placing of stones so as to always break joints both horizontally and vertically; 2d, upon the careful study and close attention given by the engineers in direct charge to every detail to see that the above methods were faithfully carried into effect; and 3d, upon the desire and endeavor on the part of the contractors to do good work and the existence of a proper relationship between them and the engineers, which the writer thinks is a most important factor in securing thoroughly satisfactory work.

From start to finish the engineers had ever before their minds the fact that they were building to resist water, one of the most subtile and persistent enemies that our profession has to cope with, and they permitted no defects in construction, however trivial they might appear at the time, to pass unremedied.

The engineers to whom was intrusted the direction of the work by the chief engineer, A. Fteley, were George B. Burbank, division engineer, and the writer as assistant engineer in charge, from the commencement until June 17, 1891, when, upon Mr. Burbank's resignation, the writer became division engineer, and assumed charge, with Frank N Speyer as his assistant.

In conclusion, the writer feels safe in saying that for water-tightness Sodom Dam rivals all masonry dams previously constructed in this country, and stands in the front rank with, if not ahead of, those built abroad.

In answer to questions put by members of the Society after the presentation of the paper, the following additional information was given by Mr. McCulloh:

Cements.—The American natural cement used was the "Union" brand from Egypt, Pennsylvania, and was delivered in heavy duck bags containing 100 lb. each, three bags constituting a barrel. The "Giant" Portland cement came from the same mill as the "Union," in bags of 100 lb. each, four bags to the barrel.

The purchaser of the cement was charged with the price of the bags, which, if returned, he was given credit for upon his next order.

No greater loss or damage to the cement was sustained in using bags than had casks been used.

Testing samples were taken at random from about ten per cent. of the bags in each lot received, and, if any question arose about the test, a second and independent set of samples was taken, and a new test made. In the average tensile strains given in the table of tests, some figures are the result of over 1,000 breaks. The lowest number of breaks is probably about 15 or 20, but the average is over 100.

Masonry in Freezing Weather.—A small portion of the dam was built in freezing weather, in December and early January of two winters. This was considered necessary, as it was desired to store water behind the dam to a certain elevation, and to do it the back half for a height of 4 or 5 ft., and 200 ft. long, was built in this way. Hot brine (5 lb. salt to 1 bbl. of water) and heated sand were used in making the mortar, and the rubble stones were also treated. Work was only allowed to proceed when the temperature was above 20° Fahr. To protect the fresh mortar at night, salt would be scattered over it, and if the conditions indicated a severe night in prospect, a layer of sand was spread over it also. No straw was used to protect masonry.

In the spring the masonry laid in winter showed only slight damage on the surface. A thin crust or scale ⅛ to ¼ in. deep could be scraped off and would disintegrate. Under this scale the mortar was in good condition and set hard.

Each spring the old mortar was gone over with sharp picks, chisel edged, to remove the scale and secure a clean, fresh surface for the new mortar to fasten to.

It was not observed that the use of hot brine and sand caused the mortar to set more rapidly than usual.

Freezing Tests of Cements.—Certain tests were made at the laboratory, both with and without using brine, to observe the effects of freezing; but they were not complete enough to draw any positive conclusions from them. The results obtained were slightly in favor of the use of salt. Mortar frozen immediately after mixing would crumble, but, upon thawing, the mass would then set very satisfactorily, the freezing simply suspending the setting. Briquettes broken after a week's exposure to frost showed slight falling off of strength, but the difference was no greater than was often observed between two sets of samples under ordinary tests.

Portland and native cements acted practically the same under the same conditions of freezing.

Cable.—The main cable was 2 in. in diameter, made of seven strands of 19 wires each, or 133 wires in all. The total length between anchors was 990 ft. The anchors, back of the towers, were oak "deadmen," 10 ft. long, 2 ft. diameter, in trenches cut 6 ft. into solid rock. Near one anchor was a turnbuckle used to take up the "stretch" due to constant use and variations in temperature—the total stretch was about 3 ft. No twisting motion in the cable was observed as a load was run out upon it. The greatest indication of wear was in the cast iron trolley wheels, which would be cut in regular spiral grooves corresponding to the strands of the cable.

Cable Failure.—The break that occurred in the first cable took place between towers, 50 ft. from the one farthest from the power house, and at the time the load was slowly moving from the power end toward the center. It parted directly over the point where the rubble stones were lifted from the trucks by the trolley. When observed, after the break, both ends were found frayed for about 10 ft., and each wire showed a contraction at the point of parting, as is the case in testing samples.

Both cables were made by Cooper, Hewitt & Co., and were of the same dimensions. The original plant was furnished by the Lidgerwood Manufacturing Co.

Preserving Batter Lines.—As each course of facing stone was completed, the true batter points for that course were established upon it by the engineers every 20 ft., using the instruments. These points were cut into the stone, and the foreman was required to work from them for each succeeding course. At each change of batter, short profiles were set by the engineers 50 ft. apart, to insure the correct setting of the first course at the new rate of batter.

THE UTILIZATION OF COAL MINES.*

THE manufacture and utilization of steam power in any large city like Kansas City is an interesting study. From the huge steam engines with their boilers and immense stacks of the manufactories down to the printing presses and elevators, there are scattered everywhere these prime movers. They take up valuable space, they require a large force of skilled mechanics, and a constant bringing of fuel to them, and this transportation of fuel is really the bringing of power from the coal mines over the railroads and roads where, ultimately, in the cities, only a low per cent. of it can be obtained.

It has always been a favorite thought with engineers to distribute these powers from some central station, and so various attempts have been made with compressed air and underground steam pipes to deliver power thus to subscribers. But the areas have been limited and the space expensive. Still, in New York and Boston, even these methods have met with commercial success.

Of course, electricians have looked upon the problem and planned methods, and even tried them with success, of bringing the power of waterfalls for such distribution in the cities. In Italy, Switzerland, and France 400 or 500 horse power is already being transported every day, and in our own country there are in operation at Ouray, in Colorado, and at Telluride and at Portland, Oregon, electrical plants which are delivering power where previously it was not a commercial success, and the source of power is a dozen miles or so away.

The first noteworthy attempt was at Frankfort, in Germany, in 1891, where 300 horse power was transmitted 112 miles, over three small wires, and delivered at 72 per cent. efficiency, lighting 10,060 lamps and running one 20 horse power motor.

Every one is watching with interest now the development of the scheme for transmitting power from Niagara Falls to Buffalo, twenty miles away, and already the shafts and tunnels at Niagara are complete, and the turbines will be put in place to operate 20,000 horse power in units of 5,000 horse power each. It is proposed to deliver this power at $66 per horse power per year at the motor in Buffalo. These items are encouraging to the electrician, and suggest the desirability of producing power outside our cities, and then bringing it there for distribution. But Kansas City is not in the vicinity of any sufficiently large water power.

The proposition seems not unfeasible to utilize some of the coal mines which lie so favorably within fifty miles of Kansas City. Here coal for boilers can be obtained at less than one-tenth the price delivered in cities for similar purposes.

In considering this fascinating problem, one must think of the various conditions to be fulfilled. The desirability is one thing, and its practical accomplishment another. I have determined, after considerable trouble—for it has never been done before—and with the kind assistance of the city boiler inspector, the amount of power used daily in Kansas City at present. I find it to be, according to the following list:

* Abstract of a lecture delivered in Kansas City, Mo., April 15, 1893, by Professor Blake, of Kansas State University.

Metropolitan Ry. Co.	Av. horse power used.	Total.
Ninth and Liberty	400	1,100
Metropolitan Ry. Co., 12th and Charlotte	350	1,000
Metropolitan Ry. Co., 18th and Olive	450	1,500
Kansas City Cable Ry	500	1,200
Grand Ave. Ry. Co., 15th and Grand Ave	500	1,250
Grand Ave. Ry. Co., Holmes St.	125	300
Tenth St. Cable Line	200	650
Northeast Electric Ry	250	325
Elevated Ry	...	1,500
Total	2,775	8,825
Armour	....	6,300
Swift	....	790
Kingan	....	250
Phœnix	....	1,085
Electric Light (Riverview)	....	360
Midland Hotel	....	550
American Light Co.	....	600
County Building	....	600
Dold's Packing House	....	600
Heim's Brewery	....	660
Water Works (two plants)	....	1,200
Coates House	....	240
New York Life Building	....	300
Bullene, More, Emery & Co	....	250
Union Depot	....	240
Massachusetts Building	....	300
Edison Co	....	1,000
All others less than 200 horse power and above 20 horse power	....	5,060
Total horse power	....	29,210

These 30,000 horse power are well scattered over the city, and represent 5½ lb. of coal to the horse power per hour, which would make 825 tons per day of ten hours. If one stops to think of all that is attendant upon this production of power, one cannot fail to be struck with the uneconomical and unsatisfactory conditions of producing it.

From an engineering standpoint, first, the engines are usually underloaded, and such use lots of coal, and when run only part of the time are not economical. Boilers have to be fired, and then quite frequently banked, so that 5½ lb. of coal per hour per horse power are required, while under continuous run for 24 hours about 3½ would perform the same duty. If power could be supplied electrically, then it could be paid for by the consumer only as used, and by meter.

Again, for the engine plants, valuable room has to be taken up; generally, therefore, rent to be paid or rent sacrificed. The water supply for steam is also quite an item. Then there must be added the wages of a skilled engineer and fireman, which might be reduced to the pay of one man, could power be supplied. Frequently too an expensive stack must be constructed, and all those accessories that go with a large plant. Then, too, there is represented the interest on machinery lying idle fourteen out of twenty-four hours, and the extra insurance which must be paid where power plants are used. Then items of minor importance come in: The ashes to be got rid of, the general undesirability of engine rooms, and also the smoke nuisance, which becomes quite a serious problem in our larger cities. The building of a power plant at the coal mines would certainly remove all these present difficulties, and, if power could be successfully transmitted, would certainly represent a commercial success.

The actual production of the power at the mines would not hardly exceed one-half its cost of production in the cities, although it is difficult to obtain accurate estimates. According to Emery's estimates made upon engines in New York City this last month, it costs per horse power per year for operating low speed condensing engines for 300 days of 10 hours each, $22.82, of which $7.92 is for coal at $2 per ton, or one-third the expense is for coal. It would seem probable from this that, including all the items mentioned above, the expense of production could be reduced to at least one-half, when produced at the mines.

In the present state of electrical science it is feasible to transmit large powers with the *direct* current up to 6 or 8 miles, and with the *multiphasal* system, 50 miles or more. This latter system is the one employed in Germany, and will be employed at Niagara Falls, and also, I am informed, on the St. Louis and Chicago electric railway. The plan here proposed is to place at the mines the power plant, use the refuse slack coal, and convert the power by dynamos into alternating currents, which shall be raised in the voltage by step-up transformers, and then transmitted to sub-stations at different parts of the city. The construction plan for a city like Kansas City may be as follows:

At these sub-stations we should have, first, for electric lighting, transformers reducing to 1,000 volts, thence over the usual line wires to similar transformers, reducing to voltage of the lamps. Second, for street car service, reduce at sub-stations to 500 volts direct current; for alternating, direct transformers are now made, thence transmitting to street cars, as at present. Third, for large factories using, say, 1,000 horse power and upward, bring direct wires from special generators at the mines to transformers at the works, and reduce there, thus using large and unbroken units for the large works. Fourth, for small motors under 100 horse power, and scattered over the city, for elevators, printing presses, etc., reduce at sub-station to 1,000 volts, and thence to transformers entering the separate buildings.

The cost of the electrical part can be only roughly stated in large units, and, as proposed at Niagara Falls, is about $180,000 for 5,000 horse power units, which includes generators, exciters, transformers, but not motors, which would be paid for by subscribers. The line construction would cost something like $1,000 per mile. Thus it would seem possible to make a successful commercial venture of such a utilization of our coal mines.

There is at least this to be said, that our best electrical companies would be prepared to make estimates upon such a project, and thus from this standpoint such a project warrants an interested and serious attention.

OUR PAVEMENTS.

By JOHN DONNELLY, Member Engineers' Club of Kansas City.

THE most important problems to the city dweller involving health and comfort are those of sewerage and pavements. Great cities with poorly paved highways are a menace to the health of the inhabitants, an added cost to all traffic and a constant source of filth and discomfort; the appearance of their streets is evidence of their style.

I believe the progress and advancement of cities is better evidenced by their pavements than other municipal improvements; first efforts being generally in the direction of providing highways that are fit for travel in all seasons by improving county roads, usually by filling the soft and spongy places with stone quarried in the vicinity or gravel from the beds or channels of neighboring streams. The location of this city furnished plenty of limestone of varying hardness and quality at elevations from the river level to 250 feet above it, and under most conditions we would use our local material in preference.

The first pavement of Kansas City done by contract in accordance with ordinance passed was begun January 8, 1857, thirty-five years ago, on the levee or steamboat landing (now Front Street) from about Walnut to Wyandotte Streets. It consisted of Telford macadam for the level or roadway part of the levee, and roughly squared blocks for the wharf or that part which sloped to the river's edge. Prices were for macadamizing $1.65, and for stone blocks $1.60 per perch. The contract does not say whether linear, square or cubic perches. I presume from the prices that square perches 16·5 feet × 1 foot were meant. This work was paid for by a loan obtained on the security of the Wharf Fund, a tax levied upon all steamboats stopping at Kansas City, of which the number averaged about ten daily at that time. No evidence of that pavement exists to-day nor has it been renewed, except eight years later in laying a track along the levee the Missouri Pacific Railroad Co. rebuilt the wharf or sloping part upon the block from Main Street to a short distance west of Delaware Street, from the line of their railroad to their ordinary level of water in the river.

From 1857 until 1880 no other form of street pavement was laid in Kansas City but macadam, using the rock that came cheapest and nearest to the work done, generally utilizing such as came from the cutting of new streets through the hills and bluffs of Kansas City.

By January 1, 1871, Kansas City had about ten miles of such pavements, and which was increased by January 1, 1880, to fifteen miles. In 1880 Fifth Street from Broadway west to Bluff Street was paved with sandstone blocks from the vicinity of Buffalo, New York (Medina stone), our first stone block pavement; and in 1882 was begun the relaying of some of our macadam streets with cedar blocks, generally upon concrete base, from which time until within the last two years the city has laid but a small amount of macadam pavement.

January 1, 1885, we had pavements aggregating 22 miles in length divided as follows:

Macadam	10·6 miles.
Cedar blocks on concrete	9·6 "
Cedar blocks on boards	0·6 "
Stone blocks	1·2 "

In 1883 Bluff Street from the Bridge to Fifth Street was paved with stone blocks of Argentine limestone, and in June, 1886, the same street was repaved with Colorado stone, replacing Argentine limestone blocks worn out after less than three years of wear.

In 1887 several streets were paved with cypress blocks from southeast Missouri and northeast Arkansas, upon the same plan usually followed in laying cedar blocks.

In 1888 the first asphalt street pavement was laid and in which the contracting company agreed to maintain the same in good order for a term of five years from and after its completion and acceptance.

Toward the close of the year 1889, the first pavement of vitrified brick was laid, and during the same year Sixth Street west of Broadway was repaved with cedar blocks, the first blocks having worn out after six and one-half years of use.

On April 1, 1890, our paved streets aggregated as follows:

Argentine limestone blocks	0·20 miles.
Asphalt	4·47 "
Cedar blocks on boards	29·91 "
" " " concrete	20·94 "
Colorado sandstone blocks	1·14 "
Cypress blocks	0·77 "
Missouri granite	0·40 "
Medina stone	0·21 "
Macadam	4·33 "
Vitrified brick	0·66 "
Total mileage	63·03 "

The decrease in the length of macadam streets is the result of repaving with other material. In 1891 we returned to the use of macadam, usually finished with a top dressing of bank gravel.

At the present time our paved streets are as follows:

Asphalt	9·66 miles.
Cedar block on concrete	21·86 "
" " " boards	29·60 "
Vitrified brick	4·02 "
Stone blocks, granite, Medina, Colorado	2·38 "
Macadam, gravel, etc.	4·21 "
Total	71·73 "

COST OF CONSTRUCTION.

Asphalt has cost from $2.25 to $2.80 per square yard according to thickness of wearing surface and concrete base necessary to lay the wearing surface.

The cost of macadam has varied from 55 to 95 cents per square yard; cedar blocks on concrete from $1.35 to $2.55 per square yard, and on boards from $1.10 to $1.75 per square yard.

Cypress blocks were laid at a reduction of about 10 cents per square yard below the prices then prevailing for cedar blocks.

Sandstone, granite, and other stone blocks cost from $2.50 to $4 per square yard.

Vitrified brick usually laid upon concrete base has cost from $1.40 to $2.10 per square yard. The prices being such as the work is let for, payable in special tax bills, and does not fully show what is the cost of brick paving because such bills are slow sale, except at a large discount.

Probably a fair statement of the cost of paving, as laid at the present time in this city and payable in special tax bills, is as follows:

	Sq. Yd.
Asphalt, business street	$2 80
Asphalt, residence street	2 50
Vitrified brick, asphalt joints	1 85
Vitrified brick, plain	1 60
Cedar blocks, repaving on concrete	1 10
Macadam	75

Macadam will last as long as you repair and take care of it. Cedar blocks on concrete will continue in fair condition for five years; and, with some attention, sprinkling and repair, it may answer for service four years longer. Cedar blocks on boards will last about four to seven years, when it gets beyond repair and must be renewed. Cypress blocks, about three years. The material appears to rot and become bad in a very short time after being laid. Colorado sandstone under heavy traffic, about five to ten years, at which time, if relaid using some new blocks, it will last an equal period. Granite blocks will ordinarily need relaying in fifteen years, but is the only kind that will endure under heavy city traffic.

Brick, if you get the right kind, will endure under ordinary traffic about ten years; on narrow streets, under heavy traffic, it can hardly last that long.

Of the durability of asphalt, I am not as well prepared to speak. The city of Washington, among the first to pave with asphalt, is still using streets paved more than fifteen years ago. Although portions of it have been patched and repaired, no general reconstruction of the street has been made. Our neighboring city of Omaha has pavements in fair condition after ten years of wear, and while seamed and cracked from shrinking of the wearing surface, are apparently good roadways and can yet be cleaned fairly by a street sweeper, and are as good for general travel as when first laid down.

At present this city contracts for brick and asphalt pavements with a guarantee of maintenance in perfect condition for a term of five years after completion. This gives some security against bad brick and improperly prepared asphalt, but with the asphalt pavements the problem will be how to protect and take care of them when this guarantee has expired.

As to how we shall pave our streets or renew our pavements in the future, I cannot foretell. I am of the opinion that but a small proportion of cedar block streets will be relaid with that material. There is some demand for its use upon portions of Pennsylvania Avenue and Eighteenth Streets, but the demand comes apparently from owners who will look for the cheapest material in preference to the best. Both streets are safe and fairly passable, although the surface is rough and uneven, and their reconstruction, as well as that of about ten miles of other streets paved with the same material, appears to be needed. In my opinion, owners fronting on such streets have received fair returns for their investment in most of the pavements now going to decay, and should a majority of the resident owners desire to reconstruct with cedar blocks upon the concrete previously placed, their wishes should be consulted and agreed to. Where the pavement to be renewed is on boards, there is no advantage in reconstructing with like material. Concrete should be placed under either blocks or brick, and I think there will be but slight difference in cost and that brick is the most durable.

Generally, most of the streets will be reconstructed in vitrified brick, mainly on account of its cost and the further fact that not one dollar of its cost need be sent away from home for material, being, like macadam, a home industry. A large portion of those decaying streets will be reconstructed with asphalt, the street pavement that will please the tenant or renter of business house and residence. When, like Main Street, a new pavement is laid, its cost represents but a week or twos' rent, even at present prices, and, although a greater first cost, the street that will attract most people can afford the highest rent, and the owner of the property is greatly interested in having the best pavement.

I do not advise laying asphalt pavements on streets having over four per cent. grade. I think asphalt on Main Street, from Missouri Avenue to Seventh Street, a mistake. It will not make a difference unless we should also repave Walnut Street and Grand Avenue, having grades about the equivalent of Main Street, five or six per cent., with like material. The effect will be to drive heavy teaming, such as coal, sand, brick, stone, etc., off those streets. It may be to the advantage of Main Street that some of this traffic be excluded, for on busy days the street is too crowded, but it will not do to deprive that traffic of a route through the business center, nor will a pavement of vitrified brick be less objectionable upon a six per cent. grade. In my belief, until the surface becomes worn and rough, a horse will have no better foothold than upon asphalt.

For the utility of the street as a thoroughfare for general teaming, Walnut Street, Grand Avenue and Twelfth Street, when the grade is in excess of three and one-half per cent., should be reconstructed with granite, or, as good and much cheaper, porphyry or jasper from the vicinity of Sioux Falls, Dakota. I do not think so well of the wearing qualities of Colorado sandstone as laid upon Bluff Street and Union Avenue. Both streets are in need of reconstruction and Bluff Street is in use but little over six years.

For our heavy traffic, let us use Missouri granite or the Dakota stone. For other business or residence streets, asphalt in such cases as those who pay for it express a preference, and generally for other streets, use vitrified brick in such portions of the city as desire their streets cleaned frequently. The three classes just named should be cleaned daily or semi-weekly by contract, to be done as often as adjacent owners may desire and at their cost.

For the remainder of our streets we will use macadam

or a combination of macadam and gravel. They are good for driving, will wear well, unless the traffic be too heavy, and answer well if they are sprinkled and taken care of by the authorities. They should be cleaned and repaired, and, in my opinion, the great objection to macadam, gravel, streets is because they are not cleaned and repaired. When you seek a reason why it is not done, you will find it is the cost of the service. In my opinion, it will cost less to construct, maintain, repair, and clean an asphalt street than a macadam or gravel street during a period of twenty years.

The cleaning of brick or asphalt can be done by machinery. The cleaning of macadam can only be done by hand labor. Therein lies the difference of cost. I suppose there will be no dispute as to which pavement is most desirable.

In conclusion, the paving question is not settled, and quite likely never will be. The city of Paris removes asphalt to put down wood; the city of London removes granite to replace it with asphalt; the city of New York covers her granite or trap (basalt) blocks with a sheet of asphalt to deaden the noise; and Chicago and St. Louis keep on putting down granite blocks as if there were no other suitable material on earth, and the more noise you have the better. A number of interior cities, from Columbus, O., to Lincoln, Neb., are using brick, and think there is no better material to be had, and in those cities fortunate enough to have parks and boulevards, such highways paved with macadam and gravel are the best and safest driveways on earth. Finally we will try to pave and repave our streets with material the choice of the men who pay for it, and trust they may become educated to know what is best.—*Jour. Assn. Engineering Societies.*

THE CAR FERRYBOAT SAINTE MARIE.

THE car ferryboat Sainte Marie, recently completed by the Detroit Dry Dock Company for the Mackinac Transportation Company, consisting of the Michigan Central, the South Shore and the Grand Rapids and Indiana railways, is by far the largest wooden boat on the lakes, and if we consider her beam, which is 5 feet more than that of any steel boat on the lakes, she lacks but little of being as large as the greatest of steel vessels on the lakes. Her engines are the most powerful on these waters, as they are expected to develop 4,000 horse power. This will drive the massive hull 15 miles an hour. The distance from St. Ignace to Mackinaw City being but 14 miles, the transfer of a whole train across the straits will occupy little more than an hour, giving as rapid ferry service as is known in the country.

The dimensions of hull and machinery are: Hull—302 feet over all, 269½ feet keel, 50½ feet beam and 24 feet deep. Machinery—Forward engine, compound, 28 and 52 inches by 40 inches; after engine, compound, 32 and 58 inches by 48 inches. Boilers—Four, 11½ by 18 feet, carrying 120 pounds steam. Wheels—Forward wheel 10½ feet; after wheel 12 feet. The forward wheel is for the purpose of breaking ice. In addition to the main engines, there are twenty auxiliary engines, among which is the Westinghouse engine that drives the dynamo for 350 incandescent lights. The construction is the heaviest known outside of war vessels. Over 2,000,000 feet of oak was used in this boat, and the hull is plated from keel to water line with steel. The system of double frames and stringer keelsons makes a double hull, and the holes cut through for the deadlights show that the inside planking, frames and outside planking have a total thickness of at least 18 inches in the part of the hull where deadlights are used.

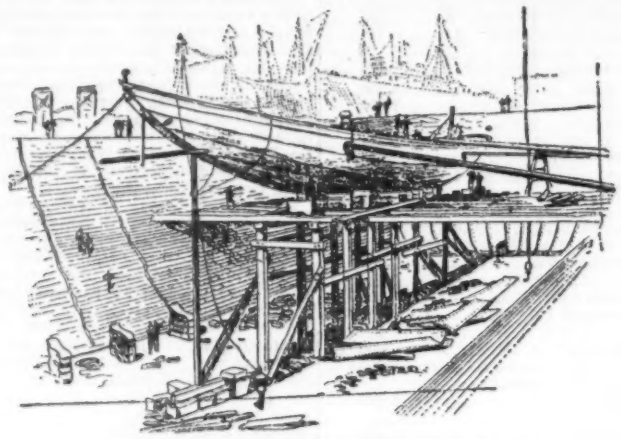
An interesting feature of the boat is the steadying tanks. The weight of the cargo is raised nearly four feet above the main deck, through its being in cars, and this would cause the boat to roll heavily in a seaway but for the tanks between decks. There are two of these tanks and each has capacity for between 10,000 and 12,000 gallons of water, one being 37 feet and the other 34 feet long. These are filled about half full of water. When the boat rolls to port this water follows slowly and passes to the port side, and when the boat is again heeled to starboard there is a resistance, which tends to steady the motion, in the weight of nearly 10,000 gallons of water, which amounts to about 42 tons. The upper deck is devoted to crew's quarters, excepting two halls for passengers. The accommodations for the crew are roomier and more comfortable than in any other boat on the lakes. With the St. Ignace and Sainte Marie in service at the straits, under the command of Commodore Boynton, nothing should go wrong at Mackinaw.—*Marine Review.*

CAR FERRYBOAT SAINTE MARIE.

THE CUP DEFENDER PILGRIM.

Since the Boston syndicate cup defender Pilgrim has been in the Erie Basin dry dock, South Brooklyn, to receive her fin keel, a great many yachtsmen have visited the place and expressed some surprise regarding her model and draught when finished. When her fin keel is on she will, indeed, be a novelty. The sketch herewith shows the appearance of the Pilgrim in the South Brooklyn dock.

The Boston boat is of steel throughout, with frames a bit heavier than some of the other cup defenders, but with fully as light plating. Extra strength has been given where extra strain is brought, and the deck is strapped in the most approved fashion. The steel plates were treated with muriatic acid before being put on. The plating is lapped, but no reduction of speed is anticipated on that account.

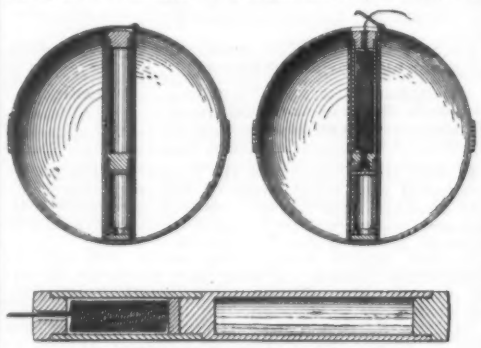


THE PILGRIM WAITING FOR HER FIN KEEL.

The water line length of the Pilgrim is 85 feet; over all length, 120 feet; breadth of beam, 23 feet; while the draught of her hull proper is 5 feet. The fin is about 17 feet 6 inches deep, so when it is bolted on, the full draught of the yacht will be 22 feet 6 inches. About twenty tons of lead will be at the bottom of the fin.—*N. Y. Herald.*

MARINE MESSENGER BALLS.

A FEW months ago we gave to the readers of the SCIENTIFIC AMERICAN SUPPLEMENT a *resume* of some of the principal life-saving devices, and we now take pleasure in giving an additional device, which might be adopted with advantage by our merchant marine.



MARINE MESSENGER BALLS.

Mr. W. B. Smith, of Lawtey, Florida, has invented several forms of marine messenger balls intended to afford a means of communication between vessels and the life-saving patrol, especially at night and in dense fogs with the wind blowing to or quartering on shore. We illustrate two forms of the signal ball, or messenger buoy as it may be termed. The ball or buoy is made of any convenient size, and is either rigid or flexible. Any suitable material may be used, and the buoy is painted any color which may be seen a long distance. The name of the vessel on which it is carried is painted on the buoy. The left hand ball (see cut) shows the simple message carrier without the rope. The message tubes are water-tight and contain indelible pencils, etc., at all times. Suitable arrangements for giving notice of the arrival of the buoy upon the beach is given by means of lights, sound signals, etc., contained in the buoy. The inventor also adds scent signals, which would doubtless prove of little use. The other cut shows a device of more value, as the line would be of great use when it reached the shore. The line is treated with melted paraffine to make it run smoothly, and is coiled in one end of the tube, which passes through the center of the sphere. Seven or eight hundred feet of life line, U. S. government No. 4, may easily be coiled up in a tube of moderate size. The other end of the tube is devoted to carrying messages and valuables, the compartment being, of course, water-tight. The same method of giving an alarm is used as in the simpler buoy. The inventor says that the trials were very satisfactory, and that one of the buoys will pay out line across a current almost as fast as being blown over the waves empty, and in one test it only required one minute longer to pay out three hundred yards across a current than to be blown across empty or simply carrying a message. The shape of the buoy enables it to pass obstructions with ease, while buoys with anchors attached are apt to foul with floating wreckage, etc.

ELECTRICAL POWER.

WE are often asked, "How does electricity accomplish its work of propelling cars and driving machinery?"

In the first place the electricity must be generated. This is done by means of a dynamo or generator actuated by an engine or by water power. A dynamo is constructed on the principle of an immense horseshoe magnet made of soft or unmagnetized iron. The arms of this magnet are wound with many coils of copper wire. If an electric current is sent through this wire, the arms become instantly and powerfully magnetized and will attract a heavy iron bar to their poles. This is called electro-magnetism. The moment the current is broken the arms are demagnetized and the iron bar drops to the ground.

Now if you force an iron bar to sweep past the poles of the magnet when the current is on, it will cut the lines of force, technically speaking, and an electric current corresponding in power to the capacity of the magnet will be conveyed into the bar, and if wires are attached to the bar, they will conduct the current to wherever it is wanted.

An armature is simply a number of parallel bars arranged compactly round a shaft, and made to revolve with great velocity near and between the magnetic poles, thus cutting their lines of force so rapidly as to induce the flow of a continuous current of electricity along the conducting wire. For simplicity of construction and efficiency of work, loops of wire are substituted for the iron bars of the armature.

A motor is a dynamo in which the direction of the electrical current is reversed. Instead of the electricity flowing from the armature into the conducting wire, the current which is generated in a dynamo is conducted into the electro-magnet and into the armature of the motor, and the loops of the armature are powerfully attracted to the poles of its electro-magnet. As each successive loop passes the center of one pole, by an ingenious device (which is too complicated to explain without a diagram) its attraction to that pole ceases and it is drawn with equal force to the opposite pole, so that while one-half of the loops on the armature of the motor are constantly attracted to the north pole, the other half are attracted with equal force to the south pole.

It is the force of this attraction which keeps the armature of the motor revolving, and this force is sufficient, when the armature is properly geared to a car axle, to turn the axle and thus propel the car.

The system of electric car locomotion then consists of:

(*a*) A dynamo or generator, in which the armature is forced to revolve so that its loops will cut the lines of force proceeding from an electro-magnet, thus generating a current of electricity; and

(*b*) A motor, in which the revolving loops of the armature are attracted to the poles of an electro-magnet through whose coils the above current is made to pass, thus forcing the armature, when properly geared, to turn the car axles.

The current is conducted from the armature of the dynamo or generator located in the power house to the overhead wire, thence through the trolley of the car to be propelled to the field of the motor, and also to its armature, which is geared to the car axle, thence through the wheels to the rails on which the car runs.

and so back to the power house, thus completing the circuit.

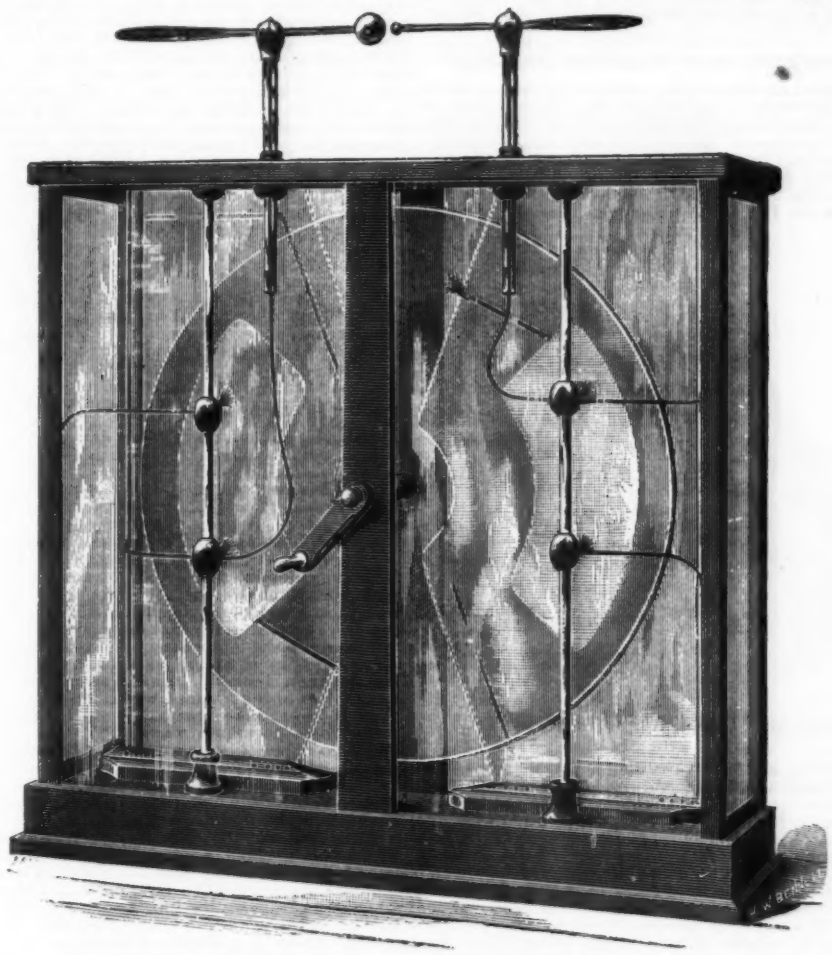
It is the office of the mortorman to break this current when he wishes to stop the car, or to complete it when he desires to proceed—in other words, to turn the current on or off at will.

Electricity is truly a mysterious force, but it acts under certain and uniform laws which have been formulated by scientists and harnessed to practical work by electricians.

Its operation is illustrated on a magnificent scale in Prof. Lowe's mountain railway, where both water power and gas engines are employed to generate the electrical current, and where the force produced not only drives the trolley cars up the steep grades and around the numerous curves of Rubio canyon, but also moves the powerful winding machinery of the great cable incline.—*Wm. H. Knight in Pasadena Star.*

THE NEW WIMSHURST INFLUENCE MACHINE.

MR. WIMSHURST'S untiring activity in the cause of electrical science has brought about the construction of another influence machine, *Engineering* says, differing entirely in construction and method of working from the type with which his name has hitherto been associated. From the illustration below, it will be seen that the new machine consists of two disks of plate glass, each 3 ft. 5 in. in diameter, and ¼ in. in thickness, mounted on one boss and spindle, about ¾ in. apart. This spindle is driven by a handle, and the disks rotate in one direction. Within the space between the two disks are fitted four vertical slips of glass, two being situated on the right hand side of the machine and two on the left. The vertical edges of the slips which come nearest the spindle are cut to an angle of 15 deg. radially; each of the two disks, therefore, is covered by the slips for nearly three-quarters of its surface. Upon each slip is a paper inductor, and on its leading edge a brush, the brush and the paper inductor being metallically connected together. These brushes are of fine wire, and touch lightly upon the inner surfaces of the disks. The glass slips are held in place by grooves at their top and bottom ends; they may be removed or replaced easily at pleasure.



THE NEW WIMSHURST INFLUENCE MACHINE.

The outer surfaces of the disks are also touched by brushes. Two brushes to each disk take the place of the usual collecting combs and obtain the charges for outside use, while two other brushes remove the remaining portions of the induced charges, the transference being from one half of the plate to the other half.

These essential parts of the machine are fitted together within a glass case, and in every way the machine is so constructed as to be useful for experimental purposes. Owing to the large size of the disks and the necessarily limited dimensions of the case, the distances between part and part are small, and the length of the sparks is limited by the insulating distances.

All the glass under excitement is coated with shellac, and when the surfaces are in good condition, and the brushes new and in proper position, the machine is self-exciting, and quickly obtains its maximum value. The direction of the electrical flow does not change even when the terminals are opened beyond striking distance; the whole of the charges then pass by way of the neutralizing brushes and circuit. When, however, the neutralizing circuit is also broken, the electrical charges are not reduced, but then they change from positive to negative with each half revolution of the disks.

As an approximate measure of the efficiency of the machine, the following experiments have been made:

The glass throughout was held free from electrical excitement, and the disks were rotated sixty times per minute. The actuating cause was then removed and the disks left to come to rest; they did so after completing 47 revolutions. This may be accepted as the measure of the friction of the journals and the brushes.

The disks were then similarly treated, but the electrical charges were allowed to form, when it was found the disks came to rest after completing 23 revolutions. The friction of the machine is therefore about equal to the electrical resistance (or the repulsion of the electrical charges).

Leyden jars, each having 8 square inches of tinfoil, were then connected to the terminals, and the terminals set 3½ in. apart. The disks were then turned to the same number of revolutions, and left to come to rest, which they did after producing 80 sparks of 3½ in. in length.

The disks were then steadily turned, and the numbers of sparks of several lengths were counted in relation to the rotation of the disks. This showed that, for each revolution, seven sparks of 1 in. length, five of 2 in. length, four of 3 in. length, and three of 4¼ in. length, were produced.

Eight metal sectors (area 14 square inches in each) were then added to each disk. With them the self-excitement becomes so free that, before any circuit whatever is made, merely presenting a finger to the rotating disk causes an electrical discharge. When the circuits are made between the several brushes the plates appear aglow with electricity, and electrical charges shoot out for a large part of the circumference of the disks. These discharges may be heard for some distance, and remind one of the beating of the floats of a paddle wheel. The display is, however, wasteful; the amount of waste may be measured by the fact that the discharges at the terminals are less by 25 per cent. than when the disks have no sectors upon them. When a pulley 3 in. in diameter was fitted to the spindle, and a weight of 15 lb. was suspended therefrom by a cord, the fall of the weight through 3 ft. produced 17 revolutions when no excitement was present, and only 10 revolutions when excitement was present. The same Leyden jars were then connected, and it was found that the fall of the weight through the 3 ft. produced 28 sparks of 3½ in. in length. Reducing this to the terms of work done in relation to the spark length, it will be seen that 1 lb. weight falling through rather less than 12 in. produces one spark of 3½ in. in length. It must not, however, be forgotten that a considerable amount of electricity is also passing by the neutralizing brushes and circuits—at least as much as by the terminals; this amount has not yet been measured.

The method of working of Mr. Wimshurst's very popular original machine, which is now to be found in all science schools and colleges, is a subject on which differences of opinion exist. The same may probably be said of the present machine. The following theory, however, seems to satisfy the conditions, and is the one followed by Mr. Wimshurst himself. As the machine starts without any artificial excitement, it is evident that there must be a difference of potential between the disks and the plates at all times, due to the differences that exist in the atmosphere. Let us assume that the disks revolve in the direction of the hands of a watch, and, following one disk, imagine a small positive charge upon it just above the fixed glass slip on the left hand side. This charge will be carried forward until it reaches the brush attached to the fixed slip on the right hand side; immediately this charge will diffuse itself over the paper inductor, leaving a free positive charge on the face of the disk in the neighborhood of the inductor. This charge will be caught by the upper brush on the glass rod, and delivered to the terminal above. Any remaining charge will be carried forward to the lower brush and delivered to the neutralizing circuit, which is connected by a wire in the base of the case to the upper brush on the glass column on the left of the machine. This brush is in contact with another part of the disk, and thus imparts to it a positive charge ready to be carried forward as described. The part of the disk leaving the inductor on the right hand side carries on its face a negative charge, which plays the same part in relation to the left hand inductor as that we have already described, and imparts a negative charge to the terminal ball on the left of the machine.

PAPER INSULATION.

MESSRS. FELTEN & GUILLEAUME have recently patented a form of lead-covered cable with paper insulation, in which full advantage is taken of the low capacity that air insulation will give. The arrangement is peculiarly well adapted for forming a quadruple cable, *i. e.*, a cable in which four conductors are used. The arrangement is shown by the figure.

The four conductors, a a^1 a^2 and a^3, lie in the four corners of a paper strip folded to a star shape and

twisted spirally: the whole is placed in a lead tube after being first lapped over with a layer of paper forming a paper tube.—*The Elec. Review.*

THE CAMBRAY SUGAR PROCESS.

[Translated for *The Louisiana Planter* from *Le Sport Colonial*, Reunion.]

THE sugar planters of Mauritius have had the good fortune of a visit from Mr. Cambray, a sugar engineer, who offers them a new, excellent and practical process, which at a slight cost permits the recovery of all the sugar now lost in the bagasse.

This process is based on the principle of diffusion, and, according to the author, its advantages arise from the rapidity of the operation, which requires scarcely five minutes, this rapidity avoiding inversion, and the more so from the fact that the *levigation* is done in a close space, without the admission of air.

The figures submitted by Mr. Cambray indicate that the new process will secure from a cane of 15 per cent. saccharine richness 12·98 of the sugar. This calculation is based upon the mills furnishing such pressure as to secure 67 per cent. extraction from cane with 13 per cent. of fiber.

Mr. Cambray changes nothing in the factories now in operation, the apparatus that he introduces being independent of those used. The bagasse coming from the ordinary mill is received by an instrument which reduces it into very slender particles. These are then sent to a warm water mixer, where the pulp is immediately saturated, producing *osmose*—in a word, an *instantaneous diffusion.*

This bagasse, forced through the levigator, is taken by a special automatic press and pressed into cakes, or bricks, under a pressure of 200 kilos. per square centimeter, the bricks being quite dry and requiring no other preparation to be used as fuel. These bricks are carried mechanically on a carrier from the press.

Mr. Cambray thus offers complete extraction and a practical means of disposing of the bagasse and making it useful fuel. This constitutes a very considerable progress and disposes of all the inconveniences in burning bagasse, and also suppresses the step-ladder furnaces now becoming quite common in the colonies.

Mr. Cambray does not stop here, but criticises the method of the Mauritians in the use of sulphurous acid. According to him, and we coincide with him, liquid sulphurous acid is detestable, and the first reason that he gives is to the point. At 20° C. water will absorb but 39 per cent. of the gas produced by burning sulphur, resulting in a loss of over 60 per cent. of the sulphur used. The sulphurous gas, according to him,

ought to be injected into the juice, not while cold, before defecation by lime, but after, until neutrality is reached, when a voluminous precipitate will be produced, requiring an adequate filtration.

We are not able to enter into all the details, and leave it to the sugar planters to read the prospectus which will be addressed to them by the Chamber of Agriculture quite soon.

The communications of Mr. Cambray are really quite interesting, and worthy of the attention of the sugar planters of the colonies. It is known that we are predisposed in favor of direct diffusion of the cane, and consider it the ideal process. We have not, however, lost view of the fact that in the colonies whatever method of extraction will be the most convenient with our old machinery will be the best, and from this point of view the Cambray process attracts attention.

AN INEXPENSIVE MICROMETER.

DURING the course of some work relative to the measurement of the earth's density, Mr. Poynting constructed a cathetometer whose micrometers are within the reach of the most modest laboratories. The spy glasses of the cathetometer carry a simple fixed reticule, the crossing point of which occupies their optical axis. In front of the objective there is a

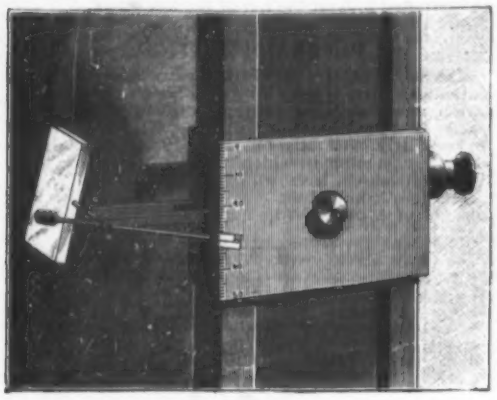


FIG. 1.—POYNTING'S MICROMETER.

plane plate of thick glass mounted upon a horizontal axis and carrying an index at right angles with its plane. Fig. 1 gives a general view of the apparatus. A revolution of the plate around its axis displaces the image to a slight degree. This stated, the following is the way in which this arrangement is capable of effecting a measurement. The spy glass having been adjusted by hand so that the point, P, to be sighted is situated near its optical axis, A B (Fig. 2), this point is brought to the crossing of the threads through a slight rotation of the glass plate. Then the cathetometer is turned around its axis in such a way as to sight a rule divided into millimeters. Through two opposite rotations of the plate, the two nearest lines are brought successively into the optical axis of the spy glass. There will thus have been obtained three positions of the plate corresponding: (1) To the lower line, (2) to the point sighted, and (3) to the upper line. A simple rule of three gives the position of the point that it is desired to determine. If, as has been done for some years already, two spy glasses have been mounted upon the cathetometer, we shall be able in this way to measure the vertical distance of two points, compare two intervals of a rule, measure the diameter of a body, etc.

The index fixed to the plate carries at its extremity a small plate of glass provided with a line whose position is read upon a vertical division. The angle that the plate forms with its normal position is therefore given by its tangent. The deviations of the image are supposed to be proportional to the reading. This pro-

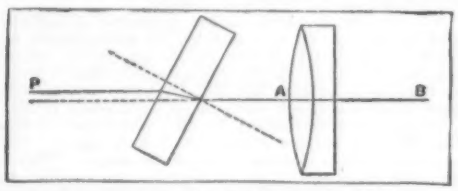


FIG. 2.—EXPLANATORY DIAGRAM.

cess is not absolutely accurate, but the errors are very slight, as shown by the following table, in the calculation of which we have supposed the index of refraction of the glass equal to 1·5 (d, thickness of the plate):

Angle.	Displacement.
5 degrees..... $\frac{d}{3}$.	0·99958 tang. 5°.
10 degrees .... $\frac{d}{3}$.	0·9995 tang. 10°.
20 degrees..... $\frac{d}{3}$.	0·999480 tang. 20°.

Now, if the plate has a thickness of 1 centimeter, the angle of 20 degrees produces a displacement of 1·2 mm., which will never be reached in practice. The error of the rough reading would be 6μ, but if one has taken care to calculate a table of correction, he can take it into account.

Mr. Poynting has, moreover, devised a system of rods that give the glass and index a motion such that the error is corrected automatically. Such correction can be effected likewise by replacing the right line of the index by a properly calculated curvilinear line.

It must be remarked that the measurements made by means of this instrument are differential, and that if the compensating plate did not have exactly parallel faces, there would result from this fact no appreciable error for the observations. It remains for us to say a few words concerning the work in the course of which Professor Poynting employed this micrometer. It was a question, as we have already said, of measuring the mean density of the earth, or, more exactly, the constant of gravitation, that is to say, the number, k, of the formula

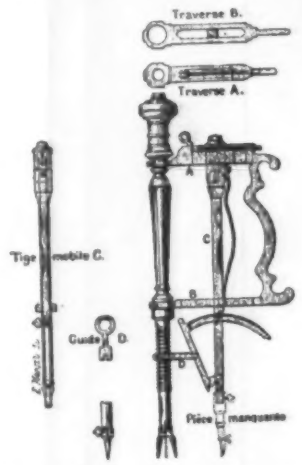
$$f = k \frac{m_1 m_2}{r^2}$$

f being the force with which the masses, m_1 and m_2, attract each other at the distance, r.

To this effect, two equal masses were suspended from the beam of a balance, and a third mass, whose attraction added itself to that of the earth to cause the beam to incline on *its* side, was placed under each in succession. The attracting mass was about 15 kilogrammes, and the suspended masses 21·5 kilogrammes. These latter were placed successively at two different heights, in order to eliminate the attraction upon the beam of the balance, impossible to calculate. The entire apparatus was placed in an isolated cellar, which, after the measurements were once begun, the observer never entered. All the maneuvers were made automatically, and the oscillations of the balance were observed by means of a telescope that passed through the floor. It took Mr. Poynting no less than a dozen years to discover all the causes of error of his method and execute definitive experiments. The result of the measurements gave as the mean density of the earth the value 5·493, which agrees in a very remarkable manner with the number found by Mr. Cornu by means of an essentially different method.—*La Nature.*

A COMPASS FOR DRAWING SPIRALS.

ONE day I discovered the curious instrument represented herewith in the shop of Mr. Claessens, one of the best bookbinders in Brussels. Mr. Claessens was entirely ignorant of the use of it and said that he got it from an old friend, who was a geometer. I asked him to lend it to me. After showing it to several persons who did not succeed in discovering the use of it, I took it to the Brussels Archæological Society, of which



COMPASS FOR DRAWING SPIRALS.

I have the honor of being a member. One of my confreres, Captain G. Ilecq, said to me: "This must be a micrometric compass." Upon showing it as such to other members and trying to explain the manipulation of it, I saw that the compass was for drawing spirals and not circles. In fact, in taking into consideration the drawing pen, which has disappeared, but which must have been fitted to the movable square rod, the movement of the apparatus will be easily understood. The rod with octagonal handle being held immovable by means of two strong points that were fixed to a board on each side of the needle (likewise absent) that was to mark the center in causing the whole apparatus to revolve around this rod, the small guide was made to rise or descend through the screw thread with which the rod is provided.

This guide, in sliding along the radius of the arc of a circle adapted to the movable rod, made the latter gradually recede from or approach the center according as the motion occurred in one direction or the other.

The other parts of the apparatus explain themselves to any one at all who is acquainted with instruments of precision. The only thing that is inexplicable up to the present is a little copper wheel placed along the rod near the handle.—*E. Michel in La Nature.*

THE DAGUERREOTYPE PROCESS.

THE demonstration of the daguerreotype process given by Mr. Wm. England recently in the rooms of the Photographic Society of Great Britain convinced those who witnessed it that, although care and skill were necessary, there was no difficulty in producing works of the greatest beauty by this discarded but ever-charming photographic process.

Unlike all other systems of photography, the personal skill of the operator is the sole factor in the achievement of success. In other methods much is dependent upon the productions of the manufacturer, as in the case of the collodion or the dry plates employed; but in this the elementary substances must be applied by the operator himself, and upon his methods of doing so depend the position he occupies in the technics of daguerreotyping; for we are for the moment putting out of sight the artistic element, the skill in posing and arranging a sitter, or in selecting a point of view in a landscape.

In its simplest form, and as it left the hands of Daguerre, the process briefly consisted in exposing a metallic plate with a silvered surface to the vapor of iodine till it became yellow by the formation of iodide of silver, then transferring it to the camera to become impressed by the action of light, developing the latent image by exposing to the fumes of mercury, finally fixing by immersion in hyposulphite of soda solution, and washing and drying. This was the process as it emanated from Daguerre, but it was slow and required a long exposure in the camera; moreover, the image was delicate, and could not withstand the most gentle touch without being destroyed. Both of these objectionable features were speedily removed. An enhanced degree of sensitiveness was imparted by the employment of bromine in addition to iodine in sensitizing the plate, while permanence (speaking from the mechanical point of view) was insured by a species of gilding.

As we know that there exists a hankering among our readers to try the daguerreotype process on account of certain qualities *sui generis*, we will here give some practical directions by which they can most easily do so without the necessity of importing special apparatus for their trials, for such now are not readily obtainable. In doing so we shall take occasion to speak of some of the by-paths of the process not to be found in the recognized manuals of that art.

Daguerreotype plates, not being now articles of manufacture or commerce, can only be obtained as a by-product from the stock of old-established dealers, or from others who may happen to have a few gross, or even dozens, by them as relics of former times. The copper backing is merely the support for the very thin facing of silver in which the picture is formed; hence the plate may be made of brass or any other metal capable of being electro-plated with silver. By whatever means obtained, it is essential that the surface be flat, and after being polished with rottenstone that it receive a high finish by a few strokes of a buff charged with dry rouge. Some prefer the use of lamp black, which, to insure freedom from grease, should be heated to redness before being bottled for subsequent use. A flat-bottomed vessel of glass or porcelain is necessary for holding the iodine. In proper iodine boxes this pan is incased in wood with an opening in one side to hold a small mirror which, when the plate has been laid face down in a holder over the top of the box, enables one to watch the progress of sensitizing, for, after a little dry iodine has been placed on the bottom of the box and the plate exposed to the vapor which arises therefrom, the pure white silver rapidly acquires a golden tint, which passes to a deeper color on to blue. At the yellow stage the plate is ready to be placed in the camera, provided the subject is a landscape or a copy in which the time of exposure is no object; but for portraiture an enhanced sensitiveness must be given, to which end it is only necessary to transfer the plate from the iodine box to a similar one containing either a little bromine greatly diluted with water enough of which to cover the bottom of the dish being sufficient, or, by preference, lime, to which a few drops of bromine have been added, and shaken up till the whole is of a uniformly pink color. When the plate is iodized to a deep yellow bordering on rose, and is then bromized to a blue, it has attained great sensitiveness, and a curious thing is that it may be examined at this stage by a light sufficiently strong to entirely destroy it for photographic purposes, but the effects of which exposure are totally destroyed by holding it over the iodine fumes for a few seconds, when the maximum of sensitiveness is thus attained. When in the camera and the sitter is seen to have moved during the exposure the value of this will be apparent, for all that is necessary to undo the latent image is to step into the dark room and hold the plate for a second or two over the iodine, when it may be again exposed, the sitter not having left his chair during this by-play. This is an advantage not to be lightly esteemed. Just here let us pause for a moment to say that some of the finest daguerreotypes we have seen were made without proper iodine and bromine boxes, ordinary porcelain jelly or jam pots having been used as substitutes, the progress of the sensitizing being watched by lifting up the plate and examining it directly.

The development is effected by exposing the plate to the invisible vapor arising from mercury which has been heated to a little over 100° Fahr. The hotter the mercury the quicker the development, and *vice versa*. This discovery is said to have been made by Daguerre's having by the advent of evening placed a half-exposed iodized plate in a drawer overnight, and finding in the morning that the image was visible, a search in the drawer revealing the fact that some globules of mercury previously therein had still found lodgment in the chinks. Proper developing boxes have a thin iron bottom with a cavity in the center for the mercury into which a thermometer bulb dips, the tube of which is carried out to a scale graduated from 100° to 120°. A spirit lamp placed underneath heats the mercury, and a small square of glass in front near the top enables the progress of development being watched, the plate being placed in a frame on the top and fixed at a slope. A yellow pane in one side permits the flame of a lamp or gas to illuminate the plate while development proceeds. It is here where the skill and experience of the operator come in, for, if the development be carried too far or not far enough, the picture suffers.

The fixing is done with hyposulphite of soda; but, in course of considerable experience with the process, we found a rather weak solution of common salt answer rather better. All that is necessary with this latter agent is to immerse the plate in the solution and touch it either at the back or one edge with a strip of zinc, when the iodide will disappear like magic. The hyposulphite acts by dissolving the iodide, this by decomposing it. Without allowing the plate to dry, it is then rendered permanent by the application of gold. A soluble salt of gold, composed of hyposulphite of soda and chloride of gold (*sel d'or*), is applied to the surface after washing, enough being poured on the leveled plate to cover it completely. Heat is then applied underneath by the spirit lamp, when, curiously, the image darkens almost to disappearance, which will alarm the tyro; but a slight continuance of the heat causes the darkening to disappear and the image to stand out in a brilliance it did not formerly possess. The lights have now become much brighter, and of a peculiarly delicate pearliness, while the blacks have become intensified; and whereas formerly the whites and all parts of the image could be removed by the

feeblest touch even of a hair pencil, they are now so fixed as to be irremovable unless by polishing powder. Instead of effecting this by heat, it suffices to add a modicum of ammonia to the hyposulphite of gold solution, when the same result is obtained by time—say ten minutes.

The brilliancy of the image may also be much improved by pouring on the surface a solution of chloride of ammonium and applying heat, by which the solarized portions which otherwise would be of a bluish color become a pure white.

We recommend those specially interested in this suggestive and charming process to visit the rooms of the Photographic Society of Great Britain, and inspect daguerreotype apparatus of the most approved construction, together with numerous beautiful specimens of daguerreotypes, colored and uncolored, which are there on exhibition.—*Br. Jour.*

AN EXPERIMENTAL STUDY OF THE SEAT OF CUTANEOUS SENSATIONS.

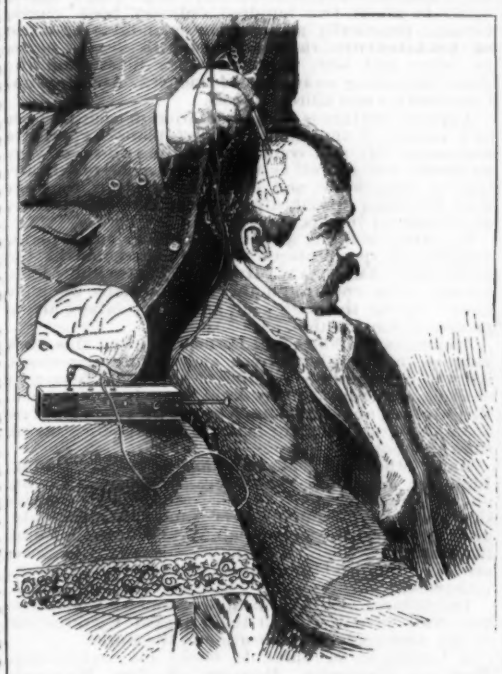
By CHARLES L. DANA, A.M., M.D., New York.

THE following case furnishes, as it seems to me, a demonstration of the fact that cutaneous and muscular sensations are closely connected, if not absolutely identified, in point of localization with the motor centers. There has been for some years a controversy as to the exact part of the brain cortex in which the centers for touch and pain and muscle sense are represented. In a paper written by myself some years ago, entitled "The Cortical Localization of Cutaneous Sensations," I collected the evidence up to date bearing on this subject, and it seemed to me that there was but one inference which could be logically drawn, and that was that the center for the sensations derived from the skin was practically identical with the motor areas of the brain. This view is the one which seems to be generally accepted in France, in Germany, and in Italy, and by most neurologists in this country. Dr. Ferrier, however, and some other English neurologists dispute this view and assert that the tactile sense has a special center which is probably in the gyrus fornicatus. So far there has been in my opinion absolutely no clinical evidence to support this, although two cases which allege to do so have been reported. The evidence so far is based upon experiments upon monkeys. On the other hand, there has been an increasing weight of clinical and pathological testimony in support of the view which I have maintained. It has been my purpose some time to present this evidence, a great deal of which I have collected and some of which seems practically demonstrative. At the present time, however, I wish only to report an experiment which, as I have already stated, seems to be of great value in connection with this discussion and also to have an independent importance to psychologists.

History of the Case and the Experiment.—The patient is a man aged thirty-six, born in New Jersey, and suffering from hereditary chorea. He was sent to my clinic nearly a year ago by Dr. George R. Elliott. At present I shall only say of it that the hereditary feature of this chorea is most extraordinary. The patient now represents the fifth generation in which this disease has developed between the thirtieth and fortieth year. It has been transmitted through the maternal side in all cases. From generation to generation a certain number of children have begun, after they reached the age of thirty, to develop choreic movements, mental deterioration, and finally to become insane and demented. My patient began to show disturbances of voluntary movement and peculiarities in articulation and temper about three years ago. The disease progressed, and in the spring of 1892 he was admitted to my service in Bellevue Hospital. After about a month, with his own consent and that of his father, he was trephined and a piece of skull measuring two by three inches was removed from the right convexity at a point over the middle part of the precentral convolution and the parts in front. The operation was done simply as a last resort and because such operations had been reported to be of temporary benefit, at least, in cases of general paresis, to which hereditary chorea bears some resemblances. The patient was unquestionably improved in many ways for three or four months after the operation, but eventually he became as bad as he was on entering the hospital. It occurred to me that I might utilize the opening in his skull for purposes of experimentation, acting, of course, with his own consent and knowledge. With this consent and having explained to him the nature of the operation I was intending to do, the experiment was begun.

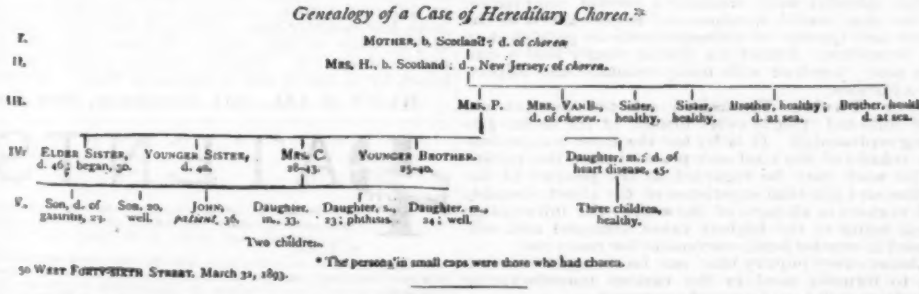
The patient's scalp was shaved and the motor areas were marked out upon it. Cocaine was injected beneath the skin where it was intended to introduce the instrument. A brain electrode consisting of two long sharp insulated needles, each connected with the cord of a Faradic battery, was then driven straight down through the scalp and into the dura mater for a distance of about half an inch. The point selected was just over the shoulder and arm center. The electric current was then turned on. After a little manipulation there was suddenly a quick convulsive movement of the left arm and shoulder, the forearm being flexed and the whole arm raised and drawn back a little. There was also a slight movement in the left foot and a little twitching in the left side of the face. The electrode was immediately withdrawn and the patient was questioned as to his sensations. He said that at the time of the movement of the arm he felt in it a numbness and heaviness, and otherwise described the feeling as though it were much the sort of sensation produced by pressure upon the nerve. The sensation came with the movement and disappeared with it. There was no pain either in the head or scalp, nor was there any pain referred to the extremities. The electrode was again introduced and the experiment was repeated. This time, with a stronger current, on making the connections the movements of the left arm, leg, and face occurred with much more violence. There were, in addition, twitching movements of the eyes. The convulsion affected slightly also the right side and there was a temporary loss of consciousness. On coming out of this the patient gave very much the same account of himself as before. He had felt a sudden numbness in the left arm and shoulder, and his description refers the sensations to that part alone, although the movement involved the whole of the left side. This feeling he could only describe again as being one of numbness or heaviness or prickling or thrilling in the moving part. Again he experienced no pain, either peripherally or locally.

This experiment, it seems to me, demonstrates beyond any doubt that there is a sensory correlative to the motor cause and that the seat of this is in the motor part of the brain cortex. The sensation which we describe as paræsthesia or numbness is practically the same as that which is produced by a diffuse stimulation of the tactile nerves of the skin. If, for example, the whole forearm and hand were gently rubbed by a layer of cotton, the sensation produced would be considered subjectively that of a feeling of numbness or formication, and this is what was produced by stimulating the cortex in this man's case; in other words, the same feeling was produced in the arm by stimulating the cortex as would be produced if the arm itself were diffusely stimulated by something that would



call out tactile sensations. The further psychology of this experiment I leave for the experts to work out. In Dr. David Ferrier's last work on cerebral localization he not only ignored a considerable part of the weighty evidence in favor of the localization of sensation in the motor areas, but did not deign to refer to some of those gentlemen who assiduously worked at this branch of investigation. I trust he will be more generous in the future. Certainly the evidence of a sensory function to the so-called motor cortex is too strong now to be treated slightingly by any one.—*Medical Record.*

*Genealogy of a Case of Hereditary Chorea.**


I. Mother, b. Scotland; d. of chorea
II. Mrs. H., b. Scotland; d., New Jersey, of chorea.
III. Mrs. P. Mrs. Van B., d. of chorea. Sister, healthy. Sister, healthy. Brother, healthy; d. at sea. Brother, healthy; d. at sea.
IV. Elder Sister, d. 46; began, 30. Younger Sister, d. 40. Mrs. C. 28-43. Younger Brother. 25-40. Daughter, m.; d. of heart disease, 45.
V. Son, d. of gastritis, 23. Son, 20, well. John, patient, 36. Daughter, m., 33. Daughter, s., 23; phthisis. Daughter, m., 24; well. Three children, healthy.
Two children.

* The persons in small caps were those who had chorea.

50 WEST FORTY-EIGHTH STREET. March 30, 1893.

FIXERS OF NITROGEN.

By M. BERTHELOT.

THE author's experiments prove that there exist microbia of very different species, free from chlorophyl, and capable of fixing nitrogen, especially certain bacteria of the soil. It is seen that the nutrition of these plants does not appear capable of being maintained by the carbon and hydrogen resulting from the decomposition of the atmospheric CO_2 and H_2O. It is correlative with the destruction of certain hydrocarbons, such as sugar or tartaric acid, which in some way act as foods for the bacteria and (other?) micro-organisms. For these beings to fix nitrogen it is necessary that they must find suitable nutriment in the medium where they live. It even appears necessary that these substances must contain some little nitrogenous matter in order to give the lower organisms the minimum of vitality necessary for the absorption of free nitrogen. But if these nitrogenous principles are too abundant, the bacterium subsists by preference at their expense.

NOTES ON CHEMICAL MANUFACTURING IN RUSSIA.

By R. BOWMAN.

IF we take the night train from Moscow and travel all night, we reach Nighni Novgorod the following morning; and by taking the steamer from there and traveling one day and night down the river Volga, and one day and night up the river Kama, we come to a little village perched upon the hillside, called in English "the quiet hills." Leaving the boat here, a drive of a quarter of an hour over the brow of the hill brings us to the only Le Blanc soda works in Russia, that of Messrs. P. K. Oushkoff & Co. The appearance of the works is a good deal different from the usual appearance of an English chemical works; the outward construction being considerably modified, owing to the enormous extremes of temperature which we have to cope with there. There is a difference of 100° C. between the extreme summer heat and the extreme cold of winter.

In the manufacture of sulphuric acid these extremes of temperature are much felt; it being necessary to have at least 25 cubic feet, but better 28 cubic feet of chamber space per pound of sulphur daily charged, to insure a good yield, combined with a low consumption of niter in the great heat of the summer months. But yet with every care and attention the results obtained are not nearly so regular as those obtained during the extreme cold of winter, the consumption of niter being greater and the yield obtained being considerably inferior to the winter work.

The cold of winter is so extreme that I have frequently found the temperature of the last chamber as low as —15° C., yet the work proceeds with great regularity, the yield being excellent with a consumption of niter averaging 1·5 lb. of the sulphur charged. Of course with these extremes of temperature it is absolutely necessary to roof and cover in both chambers and towers.

The pyrites used is of a rather inferior quality, being a cupreous pyrites of about 38 to 45 per cent. S, which we bring from our own mines in the Ural Mountains.

The major portion of our sulphuric acid we consume ourselves in the manufacture of sulphate of soda, bichromates of potash and soda, sulphate of alumina, etc. the rest being sold in the form of concentrated acid of 66° B., being concentrated partly in platinum stills and partly in glass retorts.

A few words as to our method of concentrating in glass retorts may be of interest as illustrating a method primitive in the extreme, but, under the circumstances of the case, effective. The retorts, 72 in number, are placed in three double rows of 24 each, each double row having two fireplaces at one end. Naturally those retorts nearest the fire are finished before those at the farther and cooler end; so as soon as the man in charge, on looking through the little window fixed in the door of the retort house, sees that the acid in those retorts nearest the fire is finished, he with a long rake pushes the blazing logs of wood which constitute our fuel further up the flue beneath the more distant retorts, and so on, until the whole row of 24 is finished.

The retorts themselves are made of a very common quality of glass, being the only quality of glass which we can command in the neighborhood, and are formed in shape like the ordinary laboratory retort, all in one piece, with the neck only a little shorter. This neck rests in an ordinary globular glass receiver, the receiver itself resting upon the floor of the retort house.

For the manufacture of sulphate of soda we have in use two styles of furnace: the ordinary muffle as used in the Lancashire district; and the ordinary open furnace as seen upon the Tyne. The HCl from the close furnaces is condensed by the German system of Woulf bottles, combined with wash towers, as used at Aussig, while that from the open furnaces is condensed by the English system of coke towers. It may be interesting to remark, that while both systems are worked with the greatest care and watchfulness, we find the escaping gases from the German system are always from 30 to 40 per cent. greater than that from the English system. The salt used we bring from the Astrakan district, and is of a very high quality, regularly testing 97 to 98·5 per cent. NaCl, and also of a fine open grain, dissolving with great readiness.

The whole of the HCl is used up for the manufacture of bleaching powder; the limestone for which purpose we bring from the banks of the Volga, and is of moderate quality. In bleach manufacturing again, the extremes of temperature cause many little changes in the method of working to be necessary. In beginning this manufacture in Russia, I was of course prepared for the difficulties of making a high strength bleach during the great summer heat; the difficulties of the winter I did not fear very greatly.

However, in this connection, I may mention a rather curious incident which happened during our first year of bleach making, when the outside temperature was about —25° C. A chamber of bleach which had had about one-half of its necessary quantity of gas was suddenly twisted and buckled out of shape, the roof and sides being drawn inward; notwithstanding the fact that there were two four-inch open air inlets into the chamber and that it was connected with another freshly-limed chamber.

My first impression was that this was caused by an excess of steam getting into the chamber, thereby causing with the great cold a sudden formation of chlorine hydrate; but upon careful examination of the inside of the chamber, no evidence whatever of such a formation could be found; and when the chamber was finished, the bleach was found to be a fairly normal product, testing over 36 per cent. of available chlorine, while the difference between the available and total Cl was 0·25 per cent.

Of course the bleaching powder chambers, like the sulphuric acid chambers, are entirely covered in, great care being taken to exclude every cold draught; the corridors and passages around the boxes are also heated by steam pipes, as I have found that a temperature lower than about —15° C. leads to a formation of an exceedingly hard and stone-like crust, which crust I

find not to be formed if the temperature is kept higher than that I have mentioned.

The packing of the bleach too in the summer time was found to be quite impossible in the usual English manner, *i. e.*, by the packers protecting themselves only by means of folds of flannel over the mouth and nose. The greater heat causes at the same time a more copious perspiration of the men and a greater evolution of gas from the bleach. To meet this a plan was introduced by Mr. Kovenitroff, one of the directors of the firm, which has much lessened this difficulty while being much appreciated by the men; that is a simple soft leather helmet and jacket made entirely of one piece and built upon a light framework of wire, the jacket being closed tightly at the waist and wrist, and the helmet being fitted with glass sights for the eyes, an inlet tube for air at the crown, and an outlet opposite the mouth.

The air is supplied through a half-inch India rubber tube, and is pumped in by means of an ordinary blacksmith's bellows, the outlet for the breath not finishing immediately outside the helmet, but being extended for about one and a half feet by means of an India rubber tube, which tube the workman tucks through a loop at the side of the jacket, thus keeping the air inside the helmet perfectly fresh and free from gas and enabling the workman to remain a full hour within the chamber with comfort and ease.

In the matter of sampling I may mention that I have found the samples from the chamber to be much more reliable if taken in the following way:

A thin sheet iron box of cubical form, though without top or bottom, is taken, measuring about one cubic foot in capacity, and having handles fitted to its upper edge. When it is necessary to sample a chamber, this is pushed through the crust of bleach down to the chamber floor, then all the bleach within the iron frame is lifted out, thus insuring a true average of all the layers of the product, it so being impossible to get more of one layer than another. This is done in eight or ten different parts of the chamber, and I have always found a sample so taken to give an exceedingly true idea of the average strength of the chamber.

I may also mention that I have found it a great advantage not to admit the gas, only by one, or at most two parts of the chamber, but for an ordinary 10 ton box, to admit it in five different parts. This I do by taking from the usual 6 in. main pipe 5 separate 2 in. pipes, one passing through the center of the roof of the chamber and two more at either end; this I find adds greatly to the uniformity of the product. Before adopting this method I found often a difference of from 1 to 1·5 per cent., and even in some cases 2 per cent. in the strength of the bleach taken from the end of the chamber when the gas entered and that taken from the end near the exit for the excess gas into the next chamber.

In Russia there is only a very small outlet for sulphate of soda as such, almost our entire make being used by ourselves in the manufacture of caustic soda and bichromate of soda. The caustic is made by the old Le Blanc process, the extreme climate I am glad to say having practically no effect here. The only thing worthy of note here is the impossibility of using Russian plate iron in the boiling down of even the weakest caustic liquors, the softness of the iron and the openness of its grain rendering it much more easily attacked than the English sheet iron. For this reason it is only possible to use cast iron boot pans even for the first evaporation.

Up to within quite recently manufacturing industries in Russia have been much handicapped for want of coal for fuel, the wood used each year getting dearer and dearer. Upon this point now we need have no more fear, as within the past year we have introduced the use of liquid fuel, of which we have a cheap and ample supply in the naphtha residuum from the petroleum fields at Baku. So successful has this been as fuel for chemical purposes, that we have now laid down a pipe line from our wharf on the Kama River to our works, a distance of about two miles, the naphtha being pumped direct from the barges on the river into the reservoir at the works, from which it is drawn as wanted.

In the soda works, with the exception of the first evaporation by means of the waste heat from the bell furnaces, the whole of the evaporating is done, as well as the product finished, by means of liquid fuel, with greater rapidity, cleanliness, and economy.

The whole of our steam is now raised by means of this fuel; its utility being shown by the fact that we regularly evaporate in our steam boilers upward of 14 lb. of water per lb. of fuel used; our average figure being with wood only 3¼ to 4 lb. per lb. of fuel. Before leaving to visit this country, I introduced the use of this fuel in the working of the sulphate muffle furnace with great success and economy.

But though we have in Russia much to be thankful for for the ready access we have to such an ideal fuel, chemical manufacturing in Russia is by no means a bed of roses, which you will readily believe when I say that for more than six months out of the year we have to send our products a horse and sledge journey of close upon 600 miles before we can place them upon the market, and that one horse will carry no more than 7 cwt.

The apparatus for dealing with the naphtha residues used for fuel was the common form of steam injector in which the naphtha passed into a tube with a blast of steam behind it. The steam and naphtha played upon a metal ball which vaporized the liquid fuel, and it burned more as a gas than anything else, the naphtha only igniting after it had passed out of the injector upward of 2 ft. The pyrites employed was a cupreous pyrites of 38 to 45 per cent. Two kinds of kilns were used, one the old-fashioned kiln used for the large ore, and as there was an alarming quantity of smalls with it, the other was a Schaffner & Helbig ring burner. The average temperature of the first working chamber when the lowest was at —15° he should say would range from 50° to 70° Celsius.

The bleach produced in winter was of a very fine quality indeed, the difficulty being to keep down the strength. In fact they had complaints all around from firms in Russia who had been accustomed to English bleach that theirs made in winter weather was too strong. On the other hand there were equally numerous complaints of what was made in the summer being unstable, and he was afraid of not as high quality as should be. He thought he saw his way to modify this to some extent on his return. With regard to iron decomposing pots they were very happily situated. He had had a fair experience of the unequal quality of pots supplied in England, but from three years working of pots from Ural Mountain charcoal iron he did not remember one instance of a pot turning out less than from 1,500 to 2,000 tons of salt, and in many 3,500 and upward.

The same remark applied to their caustic potash, which was of very high quality indeed. As to the packers, in mentioning the apparatus he did not wish it to be considered that he advised its use in England. He himself some years ago tried to introduce a similar apparatus, but he was afraid in this country work was carried on at too high pressure for such things to be used. The difference in the rate of work would be seen at once when he said it was customary in England to have possibly two packers for an ordinary 10 ton box of bleaching powder, and that would be done in from 5 to 7 hours. In Russia it required 25 men, and they took from 15 to 16 hours to do the work. They were not paid by the piece, such a form of payment was entirely unknown. He wished to introduce it on beginning the manufacture, but the feeling in Russia was very much against such a thing.—*Jour. Soc. Chem. Ind.*

THE SCIENTIFIC AMERICAN

Architects and Builders Edition

$2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid **Magazine of Architecture**, richly adorned with *elegant plates in colors* and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost *endless series of the latest and best examples* from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the **Largest Circulation** of any Architectural publication in the world.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilationa and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

MUNN & CO., Publishers,
361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts,

NOTES AND QUERIES.

708 PAGES. PRICE $5.

Bound in Sheep, $6.00. Half Morocco, $6.50.

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during nearly half a century past; together with many valuable and important additions.

Over Twelve Thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Instructions for working many different processes in the arts are given. How to make and prepare many different articles and goods are set forth.

Those who are engaged in any branch of industry probably will find in this book much that is of practical value in their respective callings.

Those who are in search of independent business or employment, relating to the manufacture and sale of useful articles, will find in it hundreds of most excellent suggestions.

MUNN & CO., Publishers,
361 Broadway, New York.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—Prehistoric Pottery on Exhibition at the World's Columbian Exposition.—By HENRY HALES.—Pottery from New Mexico.—The story of its discovery and illustrations of the articles.—9 illustrations 14602
The Tell el-Amarna Tablets.—By the Rev. THOMAS HARRISON.—The famous tablets and their relation to biblical chronology 14603

II. ASTRONOMY.—The Leonids or Meteors of November 13.—By DANIEL KIRKWOOD.—An interesting and popular account of the great meteoric shower of 1833, and the probability of its recurrence.—1 illustration 14604
The Recent Eclipse of the Sun.—Photographs from West Africa of the total eclipse of April 16.—3 illustrations 14605

III. CHEMISTRY.—Fixers of Nitrogen.—By M. BERTHELOT.—Fixation of nitrogen by soil organisms 14613

IV. CIVIL ENGINEERING.—Our Pavements.—By JOHN DONNELLY.—An elaborate paper on the experiences of Kansas City with different paving materials.—Their cost, duration, and availability 14609
The Construction of a Watertight Masonry Dam.—By WALTER MCCULLOH.—A full account of Sodom dam, and methods adopted to make it perfectly watertight.—5 illustrations 14606

V. COLUMBIAN EXPOSITION.—The Columbian Exposition.—By JOHN MCGOVERN.—A comprehensive and brief review of the Exposition as a whole, and of the transportation problems involved in it 14599
The International Exposition at Chicago.—A Street in Cairo.—Notes of interesting features of the Exposition, from a German observer.—2 illustrations 14600
The World's Fair at Chicago.—Spirited sketches by FREDERIC VILLIERS of scenes in the Exposition.—3 illustrations 14601

VI. ELECTRICITY.—Electrical Power.—A popular explanation of the dynamo 14610
Paper Insulation.—A lead-covered cable, with paper insulation.—1 illustration 14611
The New Wimshurst Influence Machine.—A novel construction of the well known influence machine.—1 illustration 14611

VII. MECHANICAL DRAWING.—A Compass for Drawing Spirals.—A curious relic.—A compass for producing spirals.—1 illustration 14612

VIII. MINING ENGINEERING.—The Utilization of Coal Mines.—A suggestion for establishing steam plants in coal mines to develop power at low cost 14608

IX. NATURAL HISTORY.—A Gigantic Land Turtle.—A 353 pound turtle of the Mauritius Island.—1 illustration 14605
The Beaver and His Ways.—By S. L. CLAYES.—A popular and accurate account of the life habits of the beaver and of his constructive ability 14603

X. NAVAL ENGINEERING.—Marine Messenger Balls.—Simple method of securing communication between wrecked vessels and the shore.—3 illustrations 14610
The Car Ferryboat Ste. Marie.—A powerful steamboat of 4,000 horse power for transferring cars.—1 illustration 14610
The Cup Defender Pilgrim.—The great fin keel in dry dock ready to receive her fin.—1 illustration 14610

XI. PHOTOGRAPHY.—The Daguerreotype Process.—Notes on the daguerreotype, and how to produce them 14612

XII. PHYSICS.—An Inexpensive Micrometer.—A simple and accurate cathetometer.—2 illustrations 14612
The Atmosphere.—The chemistry and physics of air.—*Resume* of most interesting series of lectures delivered by Professor Dewar at the Royal Institution 14605

XIII. PHYSIOLOGY.—An experimental study of the Seat of Cutaneous Sensations.—By CHARLES L. DANA.—The sensor and motor faculties in man.—A curious research.—1 illustration 14613

XIV. RAILROAD ENGINEERING.—The Twenty-Hour Trains Between New York and Chicago.—A review of the Exposition flyer trains run by the New York Central Railroad 14601

XV. TECHNOLOGY.—Notes on Chemical Manufacturing in Russia.—By R. BOWMAN.—The manufacture of sulphuric acid and soda and caustic alkali in Russia 14613
The Cambray Sugar Process.—A process for recovering the sugar left in the bagasse 14611

A New Catalogue of Valuable Papers

Contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address. MUNN & CO., 361 Broadway, New York.

Useful Engineering Books

Manufacturers, Agriculturists, Chemists, Engineers, Mechanics, Builders, men of leisure, and professional men, of all classes, need good books in the line of their respective callings. Our post office department permits the transmission of books through the mails at very small cost. A comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

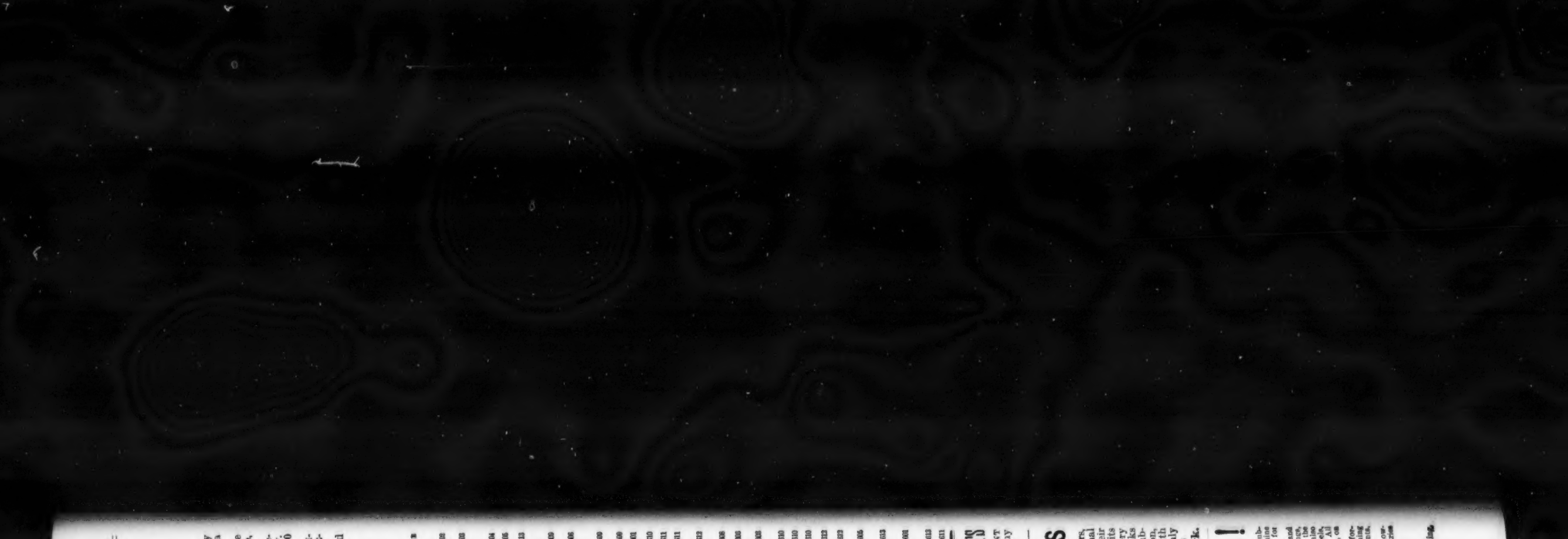
PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *forty-five years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.